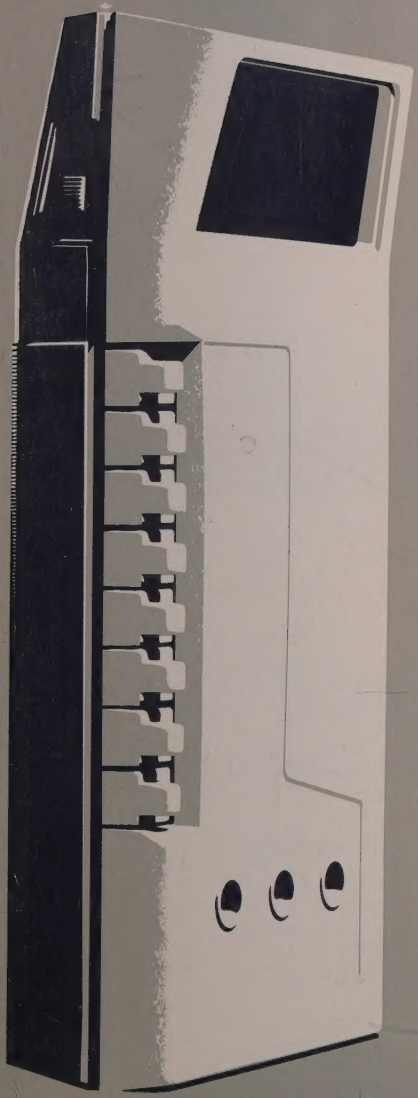
8020A

instruction manual



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NOTE

This manual documents the Model 8020A and its assemblies at the revision levels shown in Appendix A. If your instrument contains assemblies with different revision letters, it will be necessary for you to either update or backdate this manual. Refer to the supplemental change/errata sheet for newer assemblies, or to the backdating sheet in Appendix A for older assemblies.

8020A
Digital Multimeter

P/N 515825 April 1979

Dear Customer:

Congratulations! We at Fluke are proud to present you with the Model 8020A Multimeter. This instrument represents the very latest in integrated circuit and display technology. As a result, the end product is a rugged and reliable instrument whose performance and design exhibit the qualities of a finely engineered lab instrument.

To fully appreciate and protect your investment, we suggest that you take a few moments to read the manual. As always, Fluke stands behind your 8020A with a full 2-year warranty and a worldwide service organization. If the need arises, please don't hesitate to call on us.

Thank you for your trust and confidence.

JOHN FLUKE MFG. CO., INC.

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Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. Your John Fluke Model 8020A is a pocket-sized digital multimeter that is ideally suited for application in the field, lab, shop or home. Some of the features of your instrument are:

- All VOM functions plus the versatile conductance function (six in all) are included as standard.
  - DC Voltage - 100 μV to 1000V
  - AC Voltage- 100 μV to 750V
  - DC Current - 1 μA to 2000 mA
  - AC Current - 1 μA to 2000 mA
  - Resistance - 0.1Ω - 20 MΩ
  - Conductance - 0.1 nS to 200 nS and .001 mS to 2 mS (S = siemens = 1/Ω).
- CONDUCTANCE - A new multimeter function that allows fast, accurate, noise free resistance measurements up to 10,000 MΩ.
- 3 1/2 digit liquid crystal display, a high contrast display that can be read easily from across the room. No more worries about bent needles, parallax, etc.
- Each range has:
  - Full auto-polarity operation.
  - Overrange indication.
  - Effective protection for overloads up to 1000V dc and transients up to 6000V peak.
- Dual slope integration measurement technique to insure noise-free measurements.
- Long term calibration stability - 1 year. Easy calibration - few adjustments.
- Lightweight - 369 grams (13 ounces).

- Up to 200 hours of continuous operation can be expected from a single, inexpensive, 9V, alkaline battery (transistor radio/calculator type).
- Low battery voltage automatically detected and displayed.
- Line operation is possible using a Model A81 Battery Eliminator (see Section 6, Accessories).
- Protected test leads - finger guards on the probes and shrouded contacts on the connectors discourage accidental contact with circuit voltages.
- A full line of accessories that extend the range and scope of your instrument.

1-3. PREPARING FOR OPERATION

1-4. Unpacking

1-5. Your 8020A was packed and shipped in a container especially designed to protect your DMM. This manual, your multimeter, one 9V battery, and two test leads (one red and one black) should be packed in the shipping container. Check your shipment thoroughly. If anything is wrong with your shipment, contact the place of purchase immediately. If satisfaction is not obtained, contact the nearest John Fluke Service Center. A list of these service centers is located at the rear of this manual.

1-6. If reshipment is necessary, please use the original shipping container. If the original container is not available, a new one can be obtained from the John Fluke Mfg. Co., Inc. Please state the instrument model number when requesting a new shipping container.

1-7. Battery Installation/Replacement

1-8. Your 8020A is designed to operate on a single, inexpensive, 9V battery of the transistor radio/calculator variety (NEDA 1604). When you receive your 8020A,the battery will not be installed in the DMM. Once the battery is installed, you can expect a typical operating life of up to 200 hours with an alkaline battery or 100 hours with a carbon-zinc battery. When the battery has exhausted about 80% of its useful life, the BT indicator will appear in the upper left corner of the display. Your 8020A will operate properly for at least 20 hours after BT appears. Use the following procedure to install or replace the battery.

WARNING

BATTERY REPLACEMENT SHOULD ONLY BE PERFORMED AFTER THE INPUT SIGNAL AND TEST LEADS HAVE BEEN REMOVED FROM THE INPUT TERMINALS, AND THE POWER SWITCH IS SET TO OFF.

1. Set the 8020A power switch to OFF.

2. Remove test leads from external circuit connections and from the 8020A input terminals.

3. Open the battery compartment on the bottom of the 8020A using the method shown in Figure 1-1.

4. Extend the battery by sliding it toward the connector end until it can be tilted out.

5. Carefully pull the battery clip free from the battery terminals as shown in Figure 1-2.

6. Press the battery clip onto the replacement battery and return both to the battery compartment.

7. Make sure the battery and its leads are fully within the confines of the battery compartment before sliding the cover into place.

WARNING

DO NOT OPERATE THE 8020A UNTIL THE BATTERY COVER IS IN PLACE AND FULLY CLOSED.

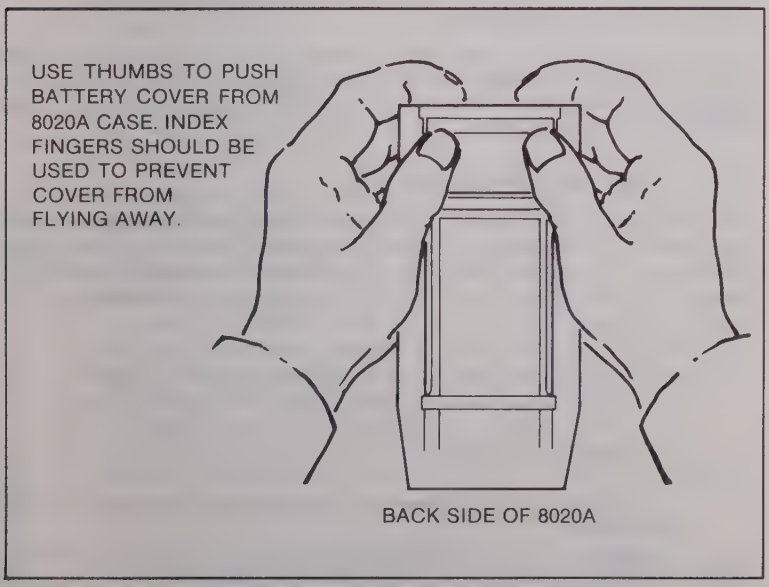

USE THUMBS TO PUSH BATTERY COVER FROM 8020A CASE. INDEX FINGERS SHOULD BE USED TO PREVENT COVER FROM FLYING AWAY.
BACK SIDE OF 8020A

Figure 1-1. Removing the Battery Cover

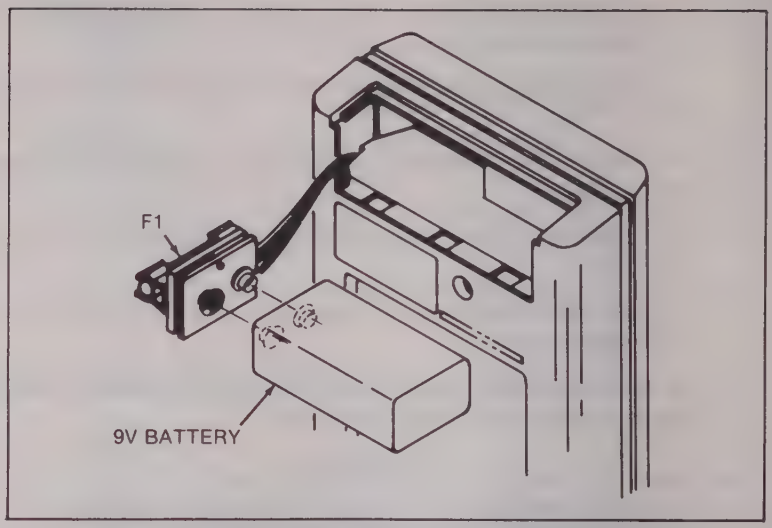


Figure 1-2. Battery Clip and Fuse Holder

1-9. PHYSICAL FEATURES

1-10. Before you try to use your 8020A, we suggest that you take a few minutes to get acquainted with your instrument. All of the externally accessible physical features of your 8020A are shown in Figure 1-3 and described in Table 1-1. Locate each feature on your 8020A as you read the description.

1-11. Initial Check-Out Procedure

1-12. Now that you have installed the battery, and know where everything is, let's make sure the unit is working properly. We'll run through a simple check-out procedure, starting with turn-on. No equipment other than the test leads will be required. If a problem is encountered, please recheck the battery, fuse, switch settings, and test lead connections before contacting your nearest authorized John Fluke Service Center.

NOTE

This procedure is intended to verify overall instrument operation, and is not meant as a substitute for the formal Performance Test given in Section 4. Limits shown exceed the specifications because the procedure uses one measurement to check another.

1. Set the power switch to OFF and all range and function switches to the released (out) position.
2. Set the power switch to ON and observe the display. It should read 00.0 ±0.1.
3. Connect the red test lead to the V/kΩ input terminal.

4. Touch the red probe tip to the COMMON input terminal, and sequentially depress each of the six grey range switches starting at the top (20 MΩ). The display should read zero ±1 digit and the decimal point should be positioned as follows:

a. 20 MΩ - 0.00
b. 2000 kΩ - 000
c. 200 kΩ - 00.0
d. 20 kΩ - 0.00
e. 2 kΩ - .000
f. 200Ω - 00.0

5. Press the 20V range switch and remove the probe from the COMMON input terminal.

6. Look inside of the battery eliminator connector on the right side of the 8020A and locate the connector contacts (center post and side contact as shown in Figure 1-1).

7. Touch the red probe tip to the center post of the battery eliminator connector. The display should read approximately –6.1V dc.

8. Touch the probe tip to the side contact of the battery eliminator connector. The display should read approximately 2.9V dc. Notice that the sum of the two readings is equal to the battery voltage (typically 8 to 10V dc). Remove the probe from the battery jack.

9. Depress the lower white button (kΩ) and sequentially depress each of the six range switches. The display should read 1 as the most significant digit with no other numbers shown. This is the standard overrange indication. Notice that the decimal point changes position with the range switch settings just as it did in step 4 of this procedure.

10. Touch the red probe tip to the COMMON input terminal, and sequentially press each of the grey buttons. The display should read zero at each range setting. Lead resistance may be sufficient to cause a one or two tenths (0.1 or 0.2Ω) indication on the 200Ω range.

11. Touch the red probe tip to the mA input connector and press the 200Ω switch. The display should read 99.0 to 101.0.

12. Press the 2 kΩ switch. The display should read .099 to .101. Remove the probe from the mA input connector.

13. Simultaneously depress the 2000 kΩ and the 20 MΩ range switches. This selects the 200 nS range. The display should read 00.0 to 01.0 (minimum conductance, maximum resistance).

14. Touch the red probe tip to the COMMON input connector. An overrange indication should be displayed since conductance is the reciprocal of resistance.

15. Connect the black test lead to the COMMON input connector.

16. Depress both AC/DC switch and the 750V ac range switch. Set the mA/V-kΩ switch to the voltage (out) position.

WARNING

THE LOCAL LINE VOLTAGE IS MEASURED IN THE FOLLOWING STEP. BE CAREFUL NOT TO TOUCH THE PROBE TIPS WITH FINGERS, OR TO ALLOW THE PROBE TIPS TO CONTACT EACH OTHER.

17. Measure the local ac line voltage at a convenient output receptacle. The voltage should be displayed with 1 volt resolution.

18. If the 8020A has responded properly to this point, it is operational and ready for use.

1-13. ACCESSORIES

1-14. Table 1-2 lists the accessories available for use with the Model 8020A. Detailed information about each accessory is provided in Section 6.

1-15. SPECIFICATIONS

1-16. Table 1-3 lists the 8020A specifications. These specifications assume a 1-year calibration cycle and an operating temperature of 18°C to 28°C (64°F to 82°F) at relative humidity up to 90% unless otherwise noted.

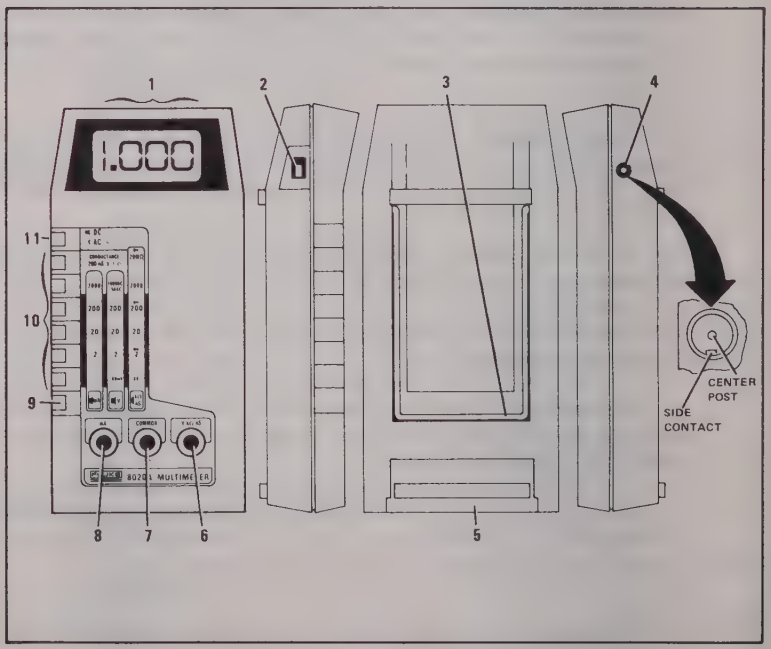


Figure 1-3. Controls, Indicators and Connectors

Table 1-1. 8020A Controls, Indicators and Connectors

ITEM NO.	NAME	FUNCTION
1	Display	A 3 1/2 digit display (1999 max) with decimal point and minus polarity indication. Used to indicate measured input values, overrange condition and low battery condition.
2	Power Switch	A slide switch used to turn the instrument off and on.
3	Tilt Bail	A removable fold-out stand which allows the instrument to be either tilted for bench-top applications or hung from a hook in the absence of a work surface.
4	Battery Eliminator and Connector	An external input power connector for use with the Model A81 Battery Eliminator accessory. (A81 is available in a variety of voltage and plug configurations. See Section 6.)
5	Battery Compartment and Cover	Cover for the 9V battery and the current-protection fuse. The cover is removed by pushing it away from the case screw.
6	V/kΩ Input Connector	Protected test lead connector used as the high input for all voltage, resistance and conductance measurements. Will accept banana plugs.
7	COMMON Input Connector	Protected test lead used as the low or common input for all measurements. Will accept banana plugs.
8	mA Input Connector	Protected test lead connector used as the high input for all current measurements. Will accept banana plugs.

Table 1-1. 8020A Controls, Indicators and Connectors (cont)

ITEM NO.	NAME	FUNCTION
9	mA/V-kΩ/nS Switch	A push-push switch (push on - push off, do not pull to select function) which operates in conjunction with the high input connectors to select either the mA/V or kΩ (conductance) measurement functions. When in or depressed it selects kΩ. The out position selects mA or V depending upon the location of the high input lead.
10	Range Switches	Interlocked push-button switches for selecting ranges, i.e., pressing the desired range switch selects that range and cancels previous switch depressions. Do not pull switches to select a range. Voltage: 200 mV, 2v, 20V, 200V, 1000V dc/750V ac Current: 2 mA, 20 mA, 200 mA, 2000 mA Resistance: 200Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, 20 MΩ Conductance: 200 nS or 2 mS (S = siemens = 1/Ω = international unit of conductance). Requires simultaneous depression of two range switches.
11	DC/AC Switch	A push-push switch (push on - push off, do not pull to select function) used to select the ac or dc measurement function when measuring current or voltage. When in, or depressed, the ac function is selected. Out selects dc. Switch may be in either position when making resistance or conductance measurements

Table 1-2. 8020A Accessories

ACCESSORY	DESCRIPTION
C90	Deluxe Carrying Case
80T-150	Temperature Probe
80I-600	Current Transformer
80K-40	High Voltage Probe
81RF	High Frequency Probe
82RF	High Frequency Probe
80J-10	Current Shunt
A81	Battery Eliminator

Table 1-3. 8020A Specifications

The following specifications assume a 1-year calibration cycle and an operating temperature of 18°C to 28°C (64°F to 82°F) at relative humidity up to 90% unless otherwise noted.

FUNCTIONS: DC Volts, AC Volts, DC Current, AC Current, Resistance, and Conductance.

DC VOLTS:

RANGE	RESOLUTION	ACCURACY FOR 1 Year
±200 mV	100 μV	±(0.1% of reading +1 digit)
±2V	1 mV	
±20V	10 mV	
±200V	100 mV	
±1000V	1V	

Overvoltage Protection: 1000V dc or peak ac on all ranges.
Input Impedance: 10MΩ, all ranges.
Normal Mode Rejection Ratio: > 60 dB at 50 Hz and 60 Hz.
Common Mode Rejection Ratio (1 kΩ unbalance): > 100 dB at dc, 50 Hz and 60 Hz.

Table 1-3. 8020A Specifications (cont)

AC VOLTS (Average Sensing, RMS Calibrated Sinewave):

RANGE	RESOLUTION	ACCURACY		
		45 Hz to 1 kHz	1 kHz to 2 kHz	2 kHz to 5 kHz
200 mV	100 μV	±(0.75% of reading +2 digits)	±(1.5% of reading +3 digits)	±(5% of reading +5 digits)
2V	1 mV			
20V	10 mV			
200V	0.1V			
750V	1V	±(1% of reading +2 digits)	Not specified	Not specified

Overload Protection: 750V rms or 1000V peak continuous, not to exceed the volt-hertz product of 10^7 except 200 mV ac ranges (15 seconds maximum above 300V rms).
Common Mode Noise Rejection Ratio (1 kΩ unbalance): > 60 dB at 50 Hz and 60 Hz.
Volt-Hz Product: 10^7 max (200V amx 50 kHz).
Input Impedance: 10 MΩ in parallel with <100 pF.

DC CURRENT:

RANGE	RESOLUTION	ACCURACY for 1 Year	BURDEN VOLTAGE
2 mA	1 μA	±(0.75% of reading +1 digit)	0.25V max.
20 mA	10 μA		
200 mA	100 μA		
2000 mA	1 mA		0.7V max.

Overload Protection: 2A/250V fuse.

Table 1-3. 8020A Specifications (cont)

AC CURRENT:

RANGE	RESOLUTION	ACCURACY for 1 Year		BURDEN VOLTAGE
		45 Hz to 450 Hz	450 Hz to 1 kHz	
2 mA	1 μA	±(2% of reading +2 digits)	Not specified	0.25V rms max.
20 mA	10 μA	±(1.5% of reading +2 digits)		
200 mA	100 μA			
2000 mA	1 mA			0.7V rms max.

Overload Protection: 2A/250V fuse.

RESISTANCE:

RANGE	RESOLUTION	ACCURACY for 1 Year	FULL-SCALE VOLTAGE	MAXIMUM TEST CURRENT
200Ω	0.1Ω	±(0.2% of reading +3 digits)	<0.25V	.35 mA
2 kΩ →|	1Ω	±(0.1% of reading +1 digit)	>1.0V	1.1 mA
20 kΩ	10Ω		<0.25V	13 μA
200 kΩ →|	100Ω		>0.7V	13 μA
2000 kΩ	1 kΩ		<0.25V	0.13 μA
20 MΩ →|	10 kΩ	±(2% of reading +1 digit)	>.7V	0.13 μA

Overload Protection: 500V dc/ac rms on all ranges.
Open Circuit Voltage: Less than 1.5V on all ranges except 2 kΩ range is less than 3.5V.
Diode Test: These three ranges have enough open circuit voltage to turn silicon junctions on, to check for proper forward-to-back resistance. The 2 kΩ range is preferred and is marked with the larger diode symbol. The three non-diode test ranges will not turn on silicon junctions so in-circuit resistance measurements can be made with these ranges.

Table 1-3. 8020A Specifications (cont)

CONDUCTANCE:

RANGE	ACCURACY
2 mS 200 nS	±(0.2% of reading +1 digit) ±(2.0% of reading +10 digits)

Overload Protection: 500V dc/rms on all ranges.
Open-Circuit Voltage:
2 mS <3.5V
200 nS <1.5V
Diode Test: Both ranges will forward bias a typical PN junction.

ENVIRONMENTAL:

Temperature: 0°C to 50°C (32°F to 122°F) operating.
-35°C to +60°C (-31°F to 140°F) storage.

Relative Humidity: 0 to 80%, 0°C to 35°C (32-95°F) on 2 MΩ, 20 MΩ and 200 nS ranges.
0 to 90%, 0°C to 35°C (32-95°F) on all other ranges.
0 to 70%, 35°C to 50°C (95-122°F).

Temperature Coefficient: <0.1 times the applicable accuracy specification per °C for 0°C to 18°C and 28°C to 50°C (32°F to 64.4°F and 50.4°F to 122°F).

GENERAL:

Maximum Common Mode Voltage: 500V dc/rms ac.
Power Requirements: Single 9V battery, NEDA 1604.
Battery Life: Alkaline: 200 hours typical.
Zinc carbon: 100 hours typical.
Battery Indicator: "BT" in display illuminates when approximately 20% of battery life remains.
Display: 3 1/2 digit LCD (2,000 count), autozero, autopolarity.
Size: L x W x H: 18.0 cm x 8.6 cm x 4.5 cm.
(7.1 in x 3.4 in x 1.8 in)
Weight: 0.37 kg (13 oz)

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. To fully utilize the measurement capabilities of your 8020A, a basic understanding of its measurement techniques and limitations is required. This section of the manual provides that information, plus a few applications that may prove useful. For example, did you know your 8020A will provide direct-reading dc current gain (Beta) measurements for both NPN and PNP transistors? Read this section of the manual, to find out how it's done.

2-3. INPUT POWER

2-4. Battery Life

2-5. The 8020A is designed to operate on a single, inexpensive 9 V battery of the transistor radio/calulator variety (NEDA 1604). If an alkaline battery is used, a typical operating life of up to 200 hours can be expected. Carbon-zinc batteries will have a useful life of up to 100 hours. In either event, the 8020A will display a BT (in upper, left-hand corner) when the battery has exhausted approximately 80% of its useful life. When BT first appears, the battery is capable of properly operating the 8020A for at least another 20 hours.

NOTE

To ensure operation within the accuracy specifications, the battery should be replaced when the voltage measured at the center of the battery eliminator connector falls below –3.00 volts (with respect to the COMMON input).

2-6. Line Power Operation

2-7. You can operate your 8020A off line power by using the A81 Battery Eliminator Accessory. Refer to Section 6 for additional information about the A81.

2-8. OPERATING NOTES

2-9. The following paragraphs should familiarize you with the capabilities and limitations of your Model 8020A and instruct you in routine operator maintenance.

2-10. Input Overload Protection

CAUTION

Exceeding the maximum input overload limits can damage the Model 8020A.

2-11. Each measurement function and its associated ranges are equipped with input overload protection. The overload limits for each function and range are given in Table 2-1.

Table 2-1. Input Overload Limits

SELECTED FUNCTION	SELECTED RANGE	INPUT CONNECTIONS	MAX. INPUT OVERLOAD
V dc or V ac	200 mV, 2V, 20V, 200V, 750V ac, 1000V dc	V/kΩ and COMMON	1000V dc or peak ac on dc ranges. 1000V dc or 750V rms on ac range - 15 seconds max. on 200 mV ac range.
mA dc or mA ac	2 mA, 20 mA, 200 mA, 2000 mA	mA and COMMON	2A max. Fuse protected in circuits with open circuit voltage ≤250V dc/rms ac. Do not use above 250V.
Ω, kΩ, MΩ, S (1/Ω)	200Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, 20 MΩ, 200 nS, 2 mS	V/kΩ and COMMON	500V dc or rms ac.
ANY	ANY	COMMON	500V dc/rms ac with respect to earth ground.

2-12. Input Connections to COMMON

WARNING

TO AVOID ELECTRICAL SHOCK AND/OR INSTRUMENT DAMAGE DO NOT CONNECT THE COMMON INPUT TERMINAL TO ANY SOURCE OF MORE THAN 500 VOLTS DC OR RMS AC ABOVE EARTH GROUND.

2-13. The 8020A may be operated with the COMMON input terminal at a potential of up to 500V dc or 500V rms ac above earth ground. If this limit is exceeded, instrument damage may occur. This, in turn, may result in a safety hazard for the operator.

2-14. Fuse Replacement

2-15. All ranges of the ac and dc current measurement functions of your 8020A are fuse protected from inadvertent application of current in excess of 2 amps. The fuse is located on the back of the battery clip. Use the Battery Installation/Replacement procedure (presented earlier in this section) to gain access to the fuse. Replace the defective fuse with type AGX2. (Instruments that accomodate metric fuses use type 171100-2.)

WARNING

DO NOT OPERATE THE 8020A UNTIL THE BATTERY COVER IS IN PLACE AND FULLY CLOSED.

2-16. The Display

2-17. The Front Panel Display on your 8020A is a 3 1/2 digit Liquid Crystal Display. The 1/2 digit is the extreme left digit location. So, the displayed value can range from 000 through 1999. For convenience in discussion, the 1999 is rounded to 2000. The decimal point position is determined by selected range and is not affected by the measurement function selected. Polarity, on the other hand is only used for the dc voltage and current measurement functions. A minus sign indicates that the input signal is negative with respect to the COMMON input terminal. Positive inputs are indicated by the absence of the minus sign.

NOTE

The minus sign (-) may flash momentarily as the 8020A comes out of an overrange condition. This will most likely be seen in the ohms mode as the open circuit test leads are applied to an in-range resistance value. If the minus sign remains on for in-range ohms readings, the circuit is live (a negative voltage is present at the input terminals due to charged capacitors, etc.) and incorrect resistance readings will be observed.

2-18. The Display has two abnormal status indicators: low battery power and instrument overrange. A "BT" is displayed when approximately 80% of the battery's life is exhausted (battery replacement is indicated). A "1" followed by three blanked digits is displayed (decimal point may be present) as an overrange indication. This does not necessarily mean that the instrument is being exposed to a damaging input condition. For example, when measuring resistance an open-input will cause an overrange indication.

2-19. The liquid crystal display used in the 8020A is a rugged and reliable unit which will give years of satisfactory service. Display life can be extended by observing the following practices:

1. Protect the display from extended exposure to bright sunlight.

2. Keep the voltmeter out of high temperature, high humidity environments, such as, the dash of a car on a hot, sunny day, otherwise the display may temporarily turn black. Recovery occurs at normal operating temperature.

3. Note that the display operation may be slowed in extremely low temperature environments. No damage will occur to the LCD, but response time is greatly increased. Recovery occurs at normal operating temperature.

2-20. OPERATION

2-21. Operation of the 8020A is an easy, four step process:

1. Set the power switch to ON.

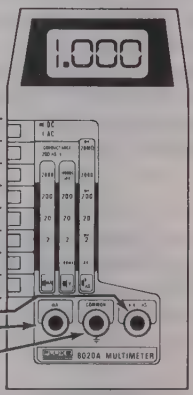
2. With reference to Figure 2-1, set the range and function switches for the desired measurement.

3. Connect the test leads to the appropriate input terminals. See Figure 2-1.

4. Contact the input signal and read the display.

Use the following table to identify the desired measurement column, and set the pushbutton switches as indicated (see notes). Connect test leads to proper input terminals.

SWITCHES (PUSH ON-PUSH OFF / PUSH-TO-SELECT)	DESIRED MEASUREMENT: Volts AC	Volts DC	Ω kΩ MΩ	mA AC	mA DC	1/Ω 200 nS	1/Ω 2 mS	Diode Test	
	■	—	—	■	—	—	—	—	AC/DC
	—	—	□	—	—	■	■	□	20MΩ
	□	□	□	□	□	■	—	—	2000
	□	□	□	□	□	—	—	□	200
	□	□	□	□	□	—	—	—	20
	□	□	□	□	□	—	■	□	2
	□	□	□	—	—	—	—	—	200Ω/mV
	—	—	■	—	—	■	■	■	mA/V,kΩ/nS
TEST LEADS	HI	HI	HI	—	—	HI	HI	HI(+)	
	—	—	—	HI	HI	—	—	—	
	LO	LO	LO	LO	LO	LO	LO	LO(-)	



NOTES:

■ = IN (Conductance (1/Ω) ranges require depression of two range switches simultaneously)
— = OUT
□ = DEPRESS ONE TO SELECT DESIRED RANGE

HI = RED, HIGH INPUT LEAD
LO = BLACK, LOW INPUT LEAD

Figure 2-1. Selecting a Function and Range

2-22. MEASUREMENT TECHNIQUES

2-23. The following paragraphs offer you techniques that improve the measurement accuracy of your 8020A. While these techniques are in general use throughout the electronics industry, these paragraphs offer specific information for use with your 8020A.

2-24. AC Measurement

2-25. The ac ranges of the 8020A employ an average responding ac converter. This means that the unit measures the average value of the input, and displays it as an equivalent rms value for a sine wave. As a result, measurement errors are introduced when the input wave form is distorted (non-sinusoidal). The amount of error depends upon the amount of distortion. Figure 2-2 shows the relationship between sine, square and triangular waveforms, and the required conversion factors.

2-26. Voltage AC/DC

2-27. The 8020A is equipped with five ac and five dc voltage ranges; 200 mV, 2V, 20V, 200V, 750V ac/1000V dc. All ranges present an input impedance of 10 MΩ. On the ac ranges, this is shunted by less than 100 pF. When making measurements, be careful not to exceed the overload limits given earlier in Table 2-1.

2-28. Measurement errors, due to circuit loading, can result when making either ac or dc voltage measurements on circuits with high source resistance. However, in most cases the error is negligible (≤01.%) as long as the source resistance of the measurement circuit is 10 kΩ or less. If circuit loading does present a problem, the percentage of error can be calculated using the appropriate formula in Figure 2-3.

2-29. Current AC/DC

2-30. Four ac and four dc current ranges are included on the 8020A; 2 mA, 20 mA, 200 mA and 2000 mA. Each range is diode protected to 2 amps and fuse protected above 2 amps. If the fuse blows, refer to fuse replacement information given earlier in this section.

2-31. In high electrical noise environments (near ignition switches, flourescent lights, relay switches, etc.) unstable or erroneous readings (exceeding specifications) may occur. The effect is most obvious when measuring low level current on the 2 mA range. If an erratic or erroneous reading is suspected, temporarily jumper the V/kΩ connector to the mA connector. This will ensure an accurate measurement.

CAUTION

To avoid possible instrument damage and/or erroneous measurements remove the temporary V/kΩ-to-mA jumper before attempting voltage or resistance measurements.

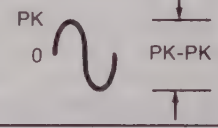
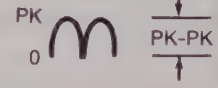
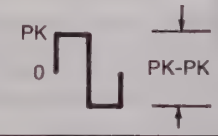
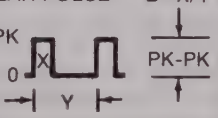
INPUT WAVEFORM	DISPLAY MULTIPLIER FOR MEASUREMENT CONVERSION			
	PK-PK	0-PK	RMS	AVG
SINE 	2.828	1.414	1.000	0.900
RECTIFIED SINE (FULL WAVE) 	1.414	1.414	1.000	0.900
RECTIFIED SINE (HALF WAVE)	2.828	2.828	1.414	0.900
SQUARE 	1.800	0.900	0.900	0.900
RECTIFIED SQUARE	1.800	1.800	1.272	0.900
RECTANGULAR PULSE D=X/Y 	0.9/D	0.9/D	$0.9/D^{1/2}$	0.9D
TRIANGLE SAWTOOTH	3.600	1.800	1.038	0.900

Figure 2-2. Waveform Conversion

1. DC VOLTAGE MEASUREMENTS

Loading Error in % = 100 x Rs (Rs + 10^7)
Where: Rs = Source resistance in ohms of circuit being measured.

2. AC VOLTAGE MEASUREMENTS

First, determine input impedance, as follows:

$$Z\,in = \frac{10^7}{\sqrt{1 + (2\pi F \bullet Rin \bullet C)^2}}$$

Where: Zin = effective input impedance
Rin = 10^7 ohms
Cin = 100 x 10^{-12} Farads
F = frequency in Hz

Then, determine source loading error as follows:

$$\text{Loading Error in \%} = \frac{100 \times Zs}{Rs + Zin}$$

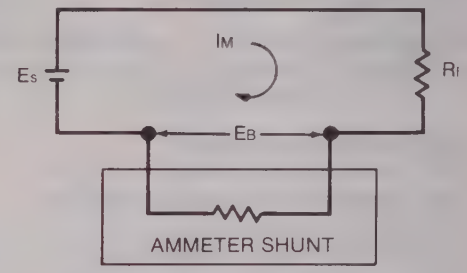
Where: Zs = source impedance
Zin = input impedance (calculated)
Rs = source resistance

Figure 2-3. Voltage Measurement Error Calculations

WARNING

INSTRUMENT DAMAGE AND OPERATOR INJURY MAY RESULT IF THE FUSE BLOWS WHILE CURRENT IS BEING MEASURED IN A CIRCUIT WHICH EXHIBITS AN OPEN CIRCUIT VOLTAGE >250 VOLTS. TO PREVENT THIS POSSIBILITY, PLACE A SUITABLE, MOUNTED AND INSULATED 1.5A FUSE OF THE PROPER VOLTAGE RATING (>250V) IN SERIES WITH THE HIGH (MA) INPUT LEAD.

2-32. Full-scale burden voltage (voltage drop across the fuse and current shunt) for all ranges except 2000 mA is less than 250 mV. The 2000 mA range has a full-scale burden voltage of less than 700 mV. These voltage drops can affect the accuracy of a current measurement, if the current source is unregulated and the shunt plus fuse resistance represents a significant portion (1/1000 or more) of the source resistance. If burden voltage does present a problem, the percentage of error can be calculated using the formula in Figure 2-4. This error can be minimized by using the highest current range that gives the necessary resolution. For example, if 20 mA is measured on the 2000 mA range the burden voltage is approximately 5 mV.



E_S = Source voltage
R_L = Load resistance + Source resistance
I_M = Measured current (display reading in amps)
E_B = Burden voltage (calculated), i.e., Display reading expressed as a % of full-scale (100 x READING FULL-SCALE) times full-scale burden voltage for selected range. See Table.

RANGE	MAXIMUM BURDEN VOLTAGE
2 mA to 200 mA	0.25V
2000 mA	0.7V

Current error due to Burden Voltage

$$\text{IN \%} = 100 \times \frac{E_B}{E_S - E_B}$$

$$\text{IN AMPS} = \frac{E_B \times I_M}{E_S - E_B}$$

Example: $E_S = 14V$, $R_L = 9\Omega$, $1M = 1.497A$,

$$EB = 100 \times \frac{1497}{2000} \times 0.7 \text{ (from Table =}$$

74.9% of 0.7 = 0.524V

$$\text{Error in \%} = 100\,\frac{.524}{14 - .524} = 100\,\frac{.524}{13.48} = 3.89\%$$

Increase displayed current by 3.89% to obtain true current.

$$\text{Error in amps} = \frac{.524 \times 1.497}{14 - .524} = \frac{.784}{13.48} = .058A$$

Increase displayed current by 0.058A to obtain true current.

Figure 2-4. Current Measurement Error Calculations

2-33. Resistance

2-34. Six direct reading resistance scales are provided on the 8020A; 20 MΩ, 2000 kΩ, 200 kΩ, 20 kΩ, 2 kΩ and 200Ω. All scales employ a two wire measurement technique. As a result, test lead resistance may influence measurement accuracy on the 200Ω range. To determine the error, short the test leads together and read the lead resistance. Correct the measurement by subtracting the lead resistance from the unknown reading. The error is generally on the order of 0.2 to 0.3 ohms for a standard pair of test leads.

2-35. In-circuit resistance measurements can be made using the 200Ω, 20 kΩ and 2000 kΩ ranges. The open circuit measurement voltage produced on these ranges is not sufficient to forward bias silicon diode/emitter-base junctions, and thus, enables resistance values to be measured without removing diodes and transistors from the circuit. Conversely, the 2 kΩ, 200 kΩ and 20 MΩ ranges produce a measurement voltage sufficient to forward bias a P-N junction. These ranges enable both diode- and transistor-junction checks to be made conveniently. Maximum open circuit voltage and short circuit current for each resistance range is given in Table 2-2. All values shown are referenced to the COMMON input terminal; i.e., the V/kΩ terminal is positive.

Table 2-2. Voltage/Current Capability of Resistance Ranges

RANGE	FULL-SCALE VOLTAGE (TYPICAL)	SHORT CIRCUIT CURRENT (TYPICAL)
20 MΩ	+800 mV	+0.12 μA
2000 kΩ	+200 mV	+0.12 μA
200 kΩ	+800 mV	+12 μA
20 kΩ	+200 mV	+12 μA
2 kΩ	+1.1V	+1.0 mA
200Ω	+55 mV	+0.3 mA

NOTE

Any change (greater than one or two digits) in apparent resistance when test leads are reversed may indicate either the presence of a diode junction or a voltage in the circuit.

CAUTION

Turn test circuit power off and discharge all capacitors before attempting in-circuit resistance measurements.

2-36. The three resistance ranges with a diode symbol beside the range value have a high enough open circuit voltage to turn a silicon junction on. These ranges - 2 kΩ, 200 kΩ, and 20 MΩ- can be used to check silicon diodes and transistors. The 2 kΩ range is preferred; it is marked with the largest diode symbol. On the ranges not marked with a diode symbol, the open circuit voltage is not high enough to turn a silicon junction on. Use these ranges to make in circuit resistance measurements. For these tests the V/kΩ input terminal is positive with respect to COMMON input terminal.

2-37. CONDUCTANCE

2-38. The conductance ranges, 200 nS and 2 mS, are included on the 8020A for making both conductance and resistance measurements. When either range is selected the display reads the measurement results in terms of conductance ($1/\Omega$). If resistance readings are required, refer to the conductance-to-resistance conversion information given in Figure 2-5.

2-39. The 200 nS range is intended for use in making fast, accurate, high-resistance measurements from 5 MΩ to 10,000 MΩ. Ordinarily, resistance measurements within this range are plagued by noise pick-up and require careful shielding. However, by measuring the resistance in terms of conductance, standard test leads are adequate for the 8020A to make noise-free measurements clear up to 10,000 MΩ. High value resistors, and low leakage components (i.e., capacitors, diodes, etc.) are natural candidates for the 200 nS conductance range. Refer to applications later in this section for additional information.

2-40. The 2 mS range, in terms of resistance, starts at 500Ω and goes up to 1 MΩ. It is intended for use in making either resistance measurements or direct-reading dc current gain (Beta) measurements on transistors. Beta measurements require the use of a special test fixture, and are discussed later in this section under applications.

2-41. APPLICATIONS

2-42. The test applications described in the following paragraphs are suggested as useful extensions of the 8020A measurement capabilities. However, they are not intended as the equivalent of manufacturer's recommended test methods. But rather, are intended to provide repeatable and meaningful indications which will allow operator to make sound judgments concerning the condition of the device tested; i.e., good, marginal, or defective.

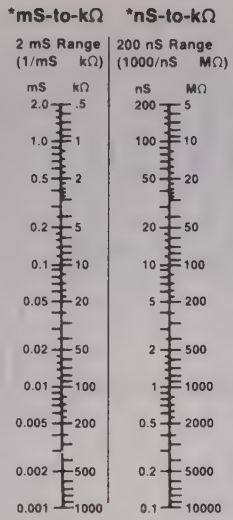
2-43. Transistor Tester

NOTE

The transistor tester described in the following paragraphs provides approximate test information. Beta is measured using a VCE of about 2V and an IC of about 200 μA. It is very useful for comparative measurements and matching.

2-44. Select the 2 mS range, plug the fixture shown in Figure 2-6 into the V/kΩ and COMMON input terminals, and you have transformed your 8020A into a transistor tester. Now, plug a transistor into the test socket and the 8020A will determine the following:

1. Transistor type (NPN or PNP).
2. Collector-to-emitter leakage (ICEs).
3. Beta from 1 to 1000 without changing range.



Conversion Scales

* *S= siemens=1/Ω=International unit of conductance formerly known as the mho.*

Find the approximate resistance value using one of the scales at left. Then, on the table below, locate the most significant digit of the display reading on the vertical NO. column, and the next digit on the horizontal NO. row. The number at the intersecting coordinates represents the unknown resistance value. For example, a reading of 52.0 nS is equal to 19.2 MΩ. Decimal point location is determined from the scale approximation.

Interpolation Table (1/no.)

NO.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	1	.909	.833	.769	.714	.667	.625	.588	.556	.526
2	.500	.476	.455	.435	.417	.400	.385	.370	.375	.345
3	.333	.323	.313	.303	.294	.286	.278	.270	.263	.256
4	.250	.244	.238	.233	.227	.222	.217	.213	.208	.204
5	.200	.196	.192	.187	.185	.182	.179	.175	.172	.169
6	.167	.164	.161	.159	.156	.154	.152	.149	.147	.145
7	.143	.141	.139	.137	.135	.133	.132	.130	.128	.127
8	.125	.123	.122	.121	.119	.118	.116	.115	.114	.112
9	.111	.110	.109	.108	.106	.105	.104	.103	.102	.101

Figure 2-5. Conductance-to-Resistance Conversion

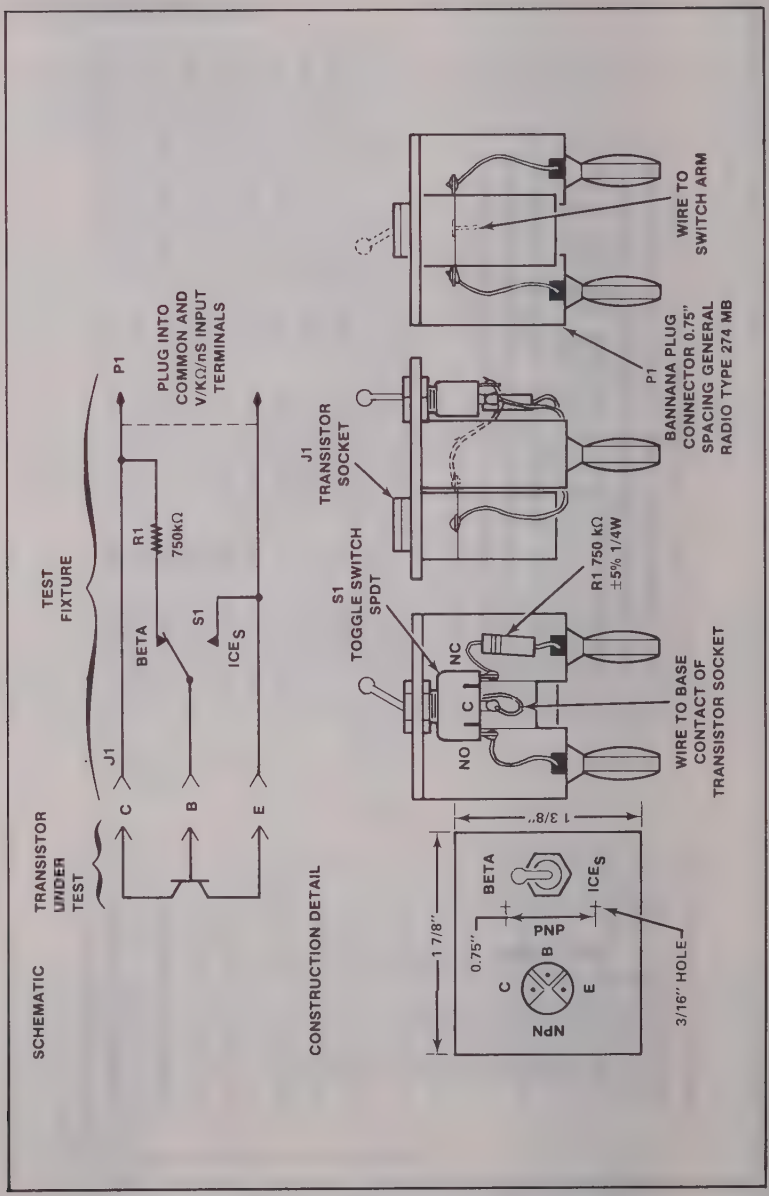


Figure 2-6. Transistor Beta Test Fixture

2-45. Transistor type is determined by setting the switch on the fixture to BETA and observing the display. If a low reading ($\leq$0.010) is obtained, reverse the test fixture at the input terminals. If the collector is now positioned at the COMMON input terminal, the transistor is a PNP type. An NPN type will have its collector positioned at the V/kΩ input terminals. If the transistor is defective the indications will be as follows regardless of fixture position:

1. A shorted transistor will cause an overload indication.

2. An open transistor will read 0.001 or less.

2-46. After the transistor fixture is properly positioned, set the switch to ICEs for the leakage test. The transistor is turned off in this test (base shorted to emitter), and should appear as a very low conductance (high resistance) from collector-to-emitter. Therefore, the lower the reading, the lower the leakage. Silicon transistors that read more than 0.002 (6 μA) should be considered questionable.

2-47. Beta is determined by setting the fixture switch to BETA, and observing the display. Mentally shift the decimal point three places to the right and read Beta directly. For example, a display reading of 0.127 indicates a dc current gain (Beta) of 127.

NOTE

Beta is a temperature sensitive parameter. Therefore, repeatable readings can only be obtained by allowing the transistor to stabilize at the ambient temperature while being tested. Avoid touching the transistor's case with your fingers.

2-48. Leakage Tester

2-49. The 200 nS conductance range effectively extends the resistance measurement capability of the 8020A (up to 10,000 MΩ) to the point where it can be used to provide useful leakage measurements on passive components. For example, you can detect leaky capacitors, diodes, cables, connectors, printed circuit boards (pcbs), etc. In all cases, the test voltage is <5V dc.

2-50. RESISTIVE COMPONENTS

2-51. Leakage testing on purely resistive components such as cables and pcbs is straightforward. Select the 200 ns range, install the test leads in the V/kΩ and COMMON input terminals, connect the leads to the desired test points on the unit-under-test, and read leakage conductance. If an overrange occurs, select the resistance range that provides an on-scale reading.

NOTE

Under high humidity conditions (>80%) conductance measurements may be in error. To ensure accurate measurements connect clean test leads to the 8020A and (with the leads open) read the residual leakage in nanosiemens. Correct subsequent measurements by subtracting the residual from the readings. (Finger prints or other contamination on the pcb may also cause residual conductance readings.)

2-52. DIODES

2-53. Diode leakage (I•R) tests require that the diode junction be reverse biased when being measured. This is accomplished by connecting the diode's anode to the COMMON input terminal and its cathode to the V/kΩ input terminal. Leakage can then be read in terms of conductance. In the event of an overrange, select a resistance range that provides an on-scale reading.

2-54. CAPACITORS

2-55. Capacitor leakage measurements are easily accomplished using the following procedure:

1. Disconnect the capacitor from its circuit.

2. Discharge the capacitor using a 100Ω resistor.

3. If the capacitor is polarity sensitive (electrolytic, etc.), identify the positive side and connect it to the 8020A's V/kΩ input. Connect the negative side to COMMON. Non-polarized capacitors can be connected either way.

4. Select the 200Ω range and allow the capacitor to assume a charge (charge time is about 5 seconds or 10 seconds/100 μF, whichever is greater).

5. Select the 200 nS range and allow the reading to stabilize. This may take awhile for larger capacitors. However, devices below 1 μF stabilize rapidly.

6. Read the leakage in terms of conductance. Overrange readings indicate a short or excessive leakage.

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2 This section of the manual contains an overall functional description followed by a block diagram analysis of the 8020A. A detailed schematic of the 8020A appears in Section 7.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. The Model 8020A as shown in Figure 3-1, is a hand-held, six function, digital multimeter. It features a total of 26 measurement ranges (V dc, 5; V ac 5; kΩ, 6; mA dc, 4; and mA ac, 4 and conductance, 2), a high contrast easy-to-read, 3 1/2 digit, liquid crystal display, long battery life (up to 200 hours); and overload protection for all ranges.

3-5. Operation centers around a custom LSI chip, U8, which is composed of a dual slope a/d converter and a display driver. Peripherals to U8 include range and function switches, input signal conditioners and the display. When an input signal is applied to the 8020A, it is routed through the range switches to one-of-four input signal conditioners as determined by the function switch setting. Each conditioner scales and, if necessary, rectifies the input so that an acceptable dc input level (−0.2 to +0.2V dc) is presented to the a/d converter.

3-6. Timing for the overall operation of the a/d converter is derived from an external quartz crystal whose frequency is a multiple of the local line frequency. This allows the conditioned dc input data to be integrated over a single line cycle, thus, optimizing both common mode and normal mode rejection.

3-7. Digitized measurement data is presented to the display as four decoded digits (seven segments) plus polarity. Decimal point position on the display is determined by the range switch settings.

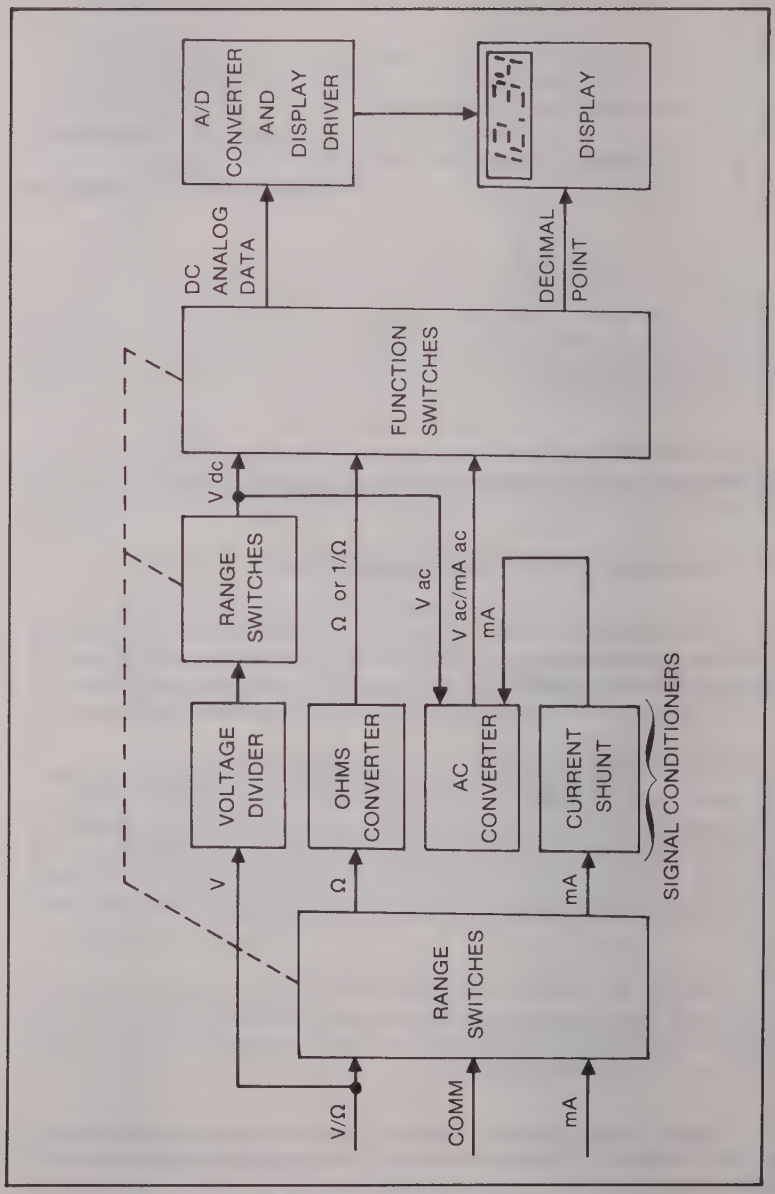


Figure 3-1. 8020A Simplified Block Diagram

3-8. BLOCK DIAGRAM ANALYSIS

3-9. A/D Converter

3-10. The entire analog-to-digital conversion process is accomplished by a single custom a d converter and Display Driver IC, U8. The IC employs the dual slope method of a d conversion, and requires a series of external components to establish the basic timing and reference levels required for operation. These include an integrating capacitor, an autozero capacitor, and a flying capacitor (for applying a reference level of either polarity). Since the power consumed for display operation is very low, the a d converter IC also contains the display latches, decoders and drivers.

3-11. The digital control portion of the a d conversion process is an internal function of U8, and is keyed to the external crystal frequency. As a result, the conversion process is continuously repeated, and the display is updated at the end of every conversion cycle.

3-12. A simplified circuit diagram of the analog portion of the a d converter is shown in Figure 3-2. Each of the switches shown represent analog gates which are operated by the digital section of the a/d converter. Basic timing for switch operation and, therefore, a complete measurement cycle is also included in the figure.

3-13. Any given measurement cycle performed by the a d converter can be divided into three consecutive time periods, autozero (AZ), integrate (INTEG), and read. Both autozero and integrate are fixed time periods whose lengths are multiples of the clock frequency. A counter determines the length of both time periods by providing an overflow at the end of every 10,000 clock pulses. The read period is a variable time which is proportional to the unknown input voltage. The value of the voltage is determined by counting the number of clock pulses that occur during the read period.

3-14. During autozero a ground reference is applied as an input to the a d converter. Under ideal conditions the output of the comparator would also go to zero. However, input-offset-voltage errors accumulate in the amplifier loop, and appear at the comparator output as an error voltage. This error is impressed across the AZ capacitor where it is stored for the remainder of the measurement cycle. The stored level is used to provide offset voltage correction during the integrate and read periods.

3-15. The integrate period begins at the end of the autozero period. As the period begins, the AZ switch opens and the INTEG switch closes. This applies the unknown input voltage to the input of the a/d converter. The voltage is buffered and passed on to the integrator to determine the charge rate (slope) on the INTEG capacitor. At the end of the fixed integrate period, the capacitor is charged to a level proportional to the unknown input voltage. This voltage is translated to a digital indication by discharging the capacitor at a fixed rate during the read period, and counting the number of clock pulses that occur before it returns to the original autozero level.

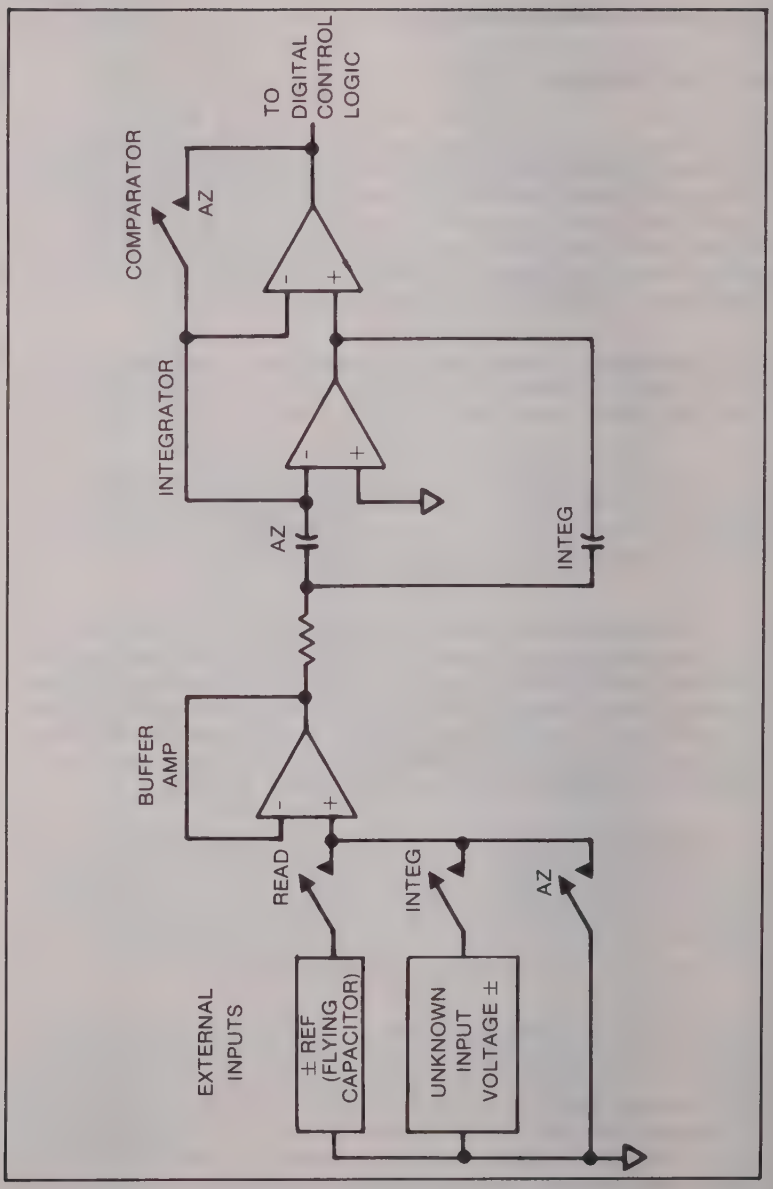


Figure3-2. Dual Slope A/D Converter

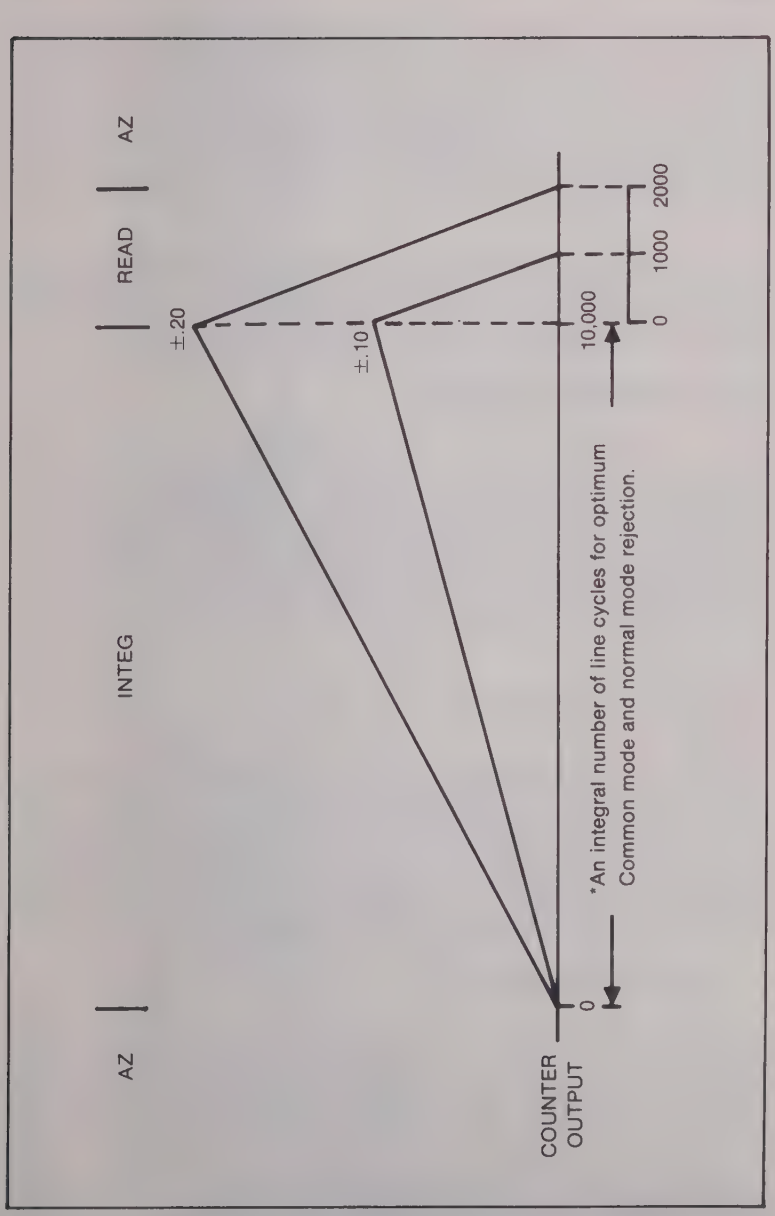


Figure 3-2. Dual Slope A/D Converter (cont)

3-16. As the read period begins, the INTEG switch opens and the read switch closes. This applies a known reference voltage to the input of the a/d converter. The polarity of this voltage is automatically selected to be opposite that of the unknown input voltage, thus, causing the INTEG capacitor to discharge at a fixed rate (slope). When the charge is equal to the initial starting point (autozero level), the read period is ended. Since the discharge slope is fixed during the read period, the time required for discharge is proportional to the unknown input voltage.

3-17. The autozero period and, thus, a new measurement cycle begins at the end of the read period. At the same time the counter is released for operation by transferring its contents (previous measurement value) to a series of latches. This stored data is then decoded and buffered before being used for driving the liquid crystal display.

3-18. Input Signal Conditioners

3-19. The a/d converter requires two externally supplied input voltages to complete a measurement cycle. One is reference voltage and the other is an unknown dc voltage within the range of -0.2 to +0.2V dc. If the function being measured is other than a dc voltage within the ±0.2 range, it must be scaled and/or conditioned before being presented to the a/d converter. For example, higher dc levels must be divided; ac inputs must be divided, rectified, and filtered; and resistance and current inputs must be scaled and converted to dc voltage levels. The following paragraphs describe the input signal conditioners used for each of the 8020A measurement functions.

3-20. VOLTAGE MEASUREMENT

3-21. Both the ac and dc voltage ranges use an over-voltage-protected, 10 MΩ input divider as shown in View A. Under normal conditions, assuming a dc input level on the proper range, the divider output is a -0.2 to +0.2V dc signal, and is an exact (power-of-10) ratio of the input signal. If the VAC function is selected, the divider output is ac coupled to an active full-wave rectifier whose dc output is calibrated to equal the rms level of the ac inputs. The conditioned signal for the selected function (V ac or V dc) is then passed through a filter before being presented to the a/d converter as the unknown input.

3-22. CURRENT MEASUREMENT

3-23. Current measurements are made using a fuse protected, switchable, four-terminal current shunt (0.1Ω, 1Ω, 10Ω, or 100Ω) to perform the current-to-voltage conversion required by the a/d converter. See View B. The voltage (I•R) drops produced across the selected shunt may be either ac or dc depending upon the selected function, mA AC or mA DC. If the input current is dc and the dc function is selected, the I•R drop is passed through a low-pass filter, and presented as the unknown input to the a/d converter. However, if the input current is ac and the AC function is selected, the I•R drop is rectified by the ac converter before going to the low-pass filter. In either event the a/d converter receives a dc input voltage proportional to the current passing through the selected shunt.

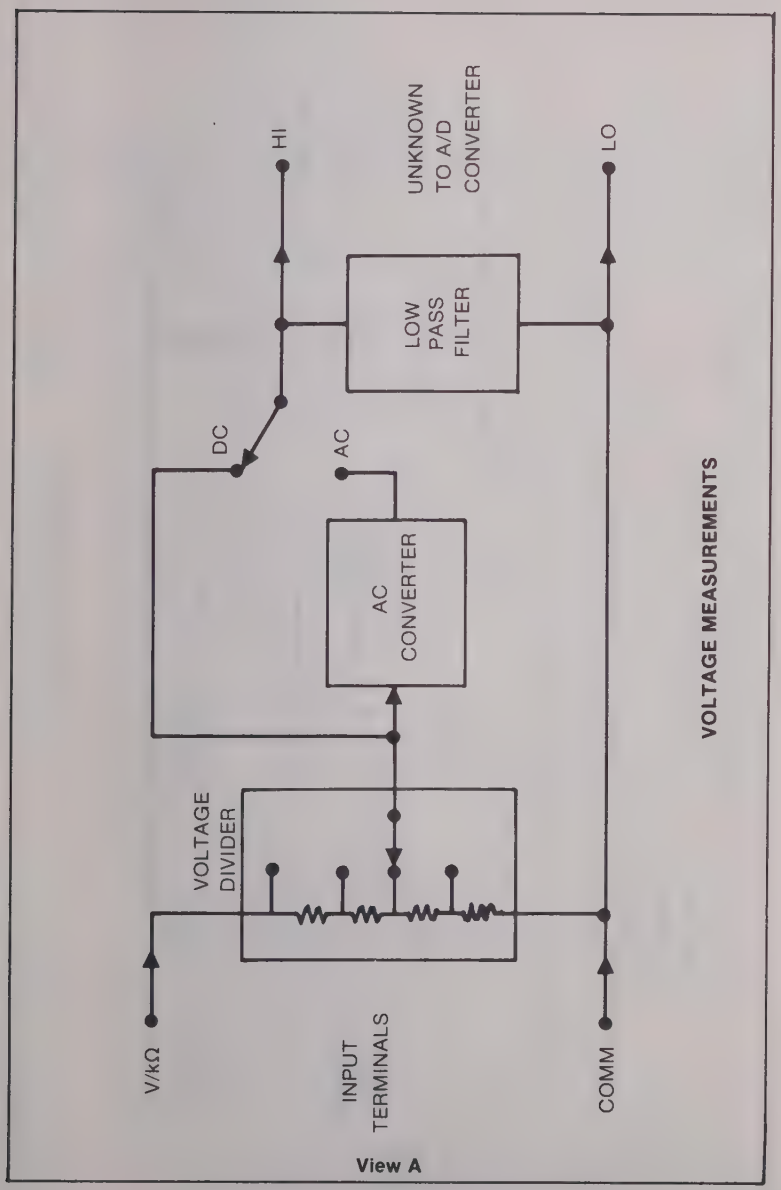


Figure 3-3. Input Signal Conditioners

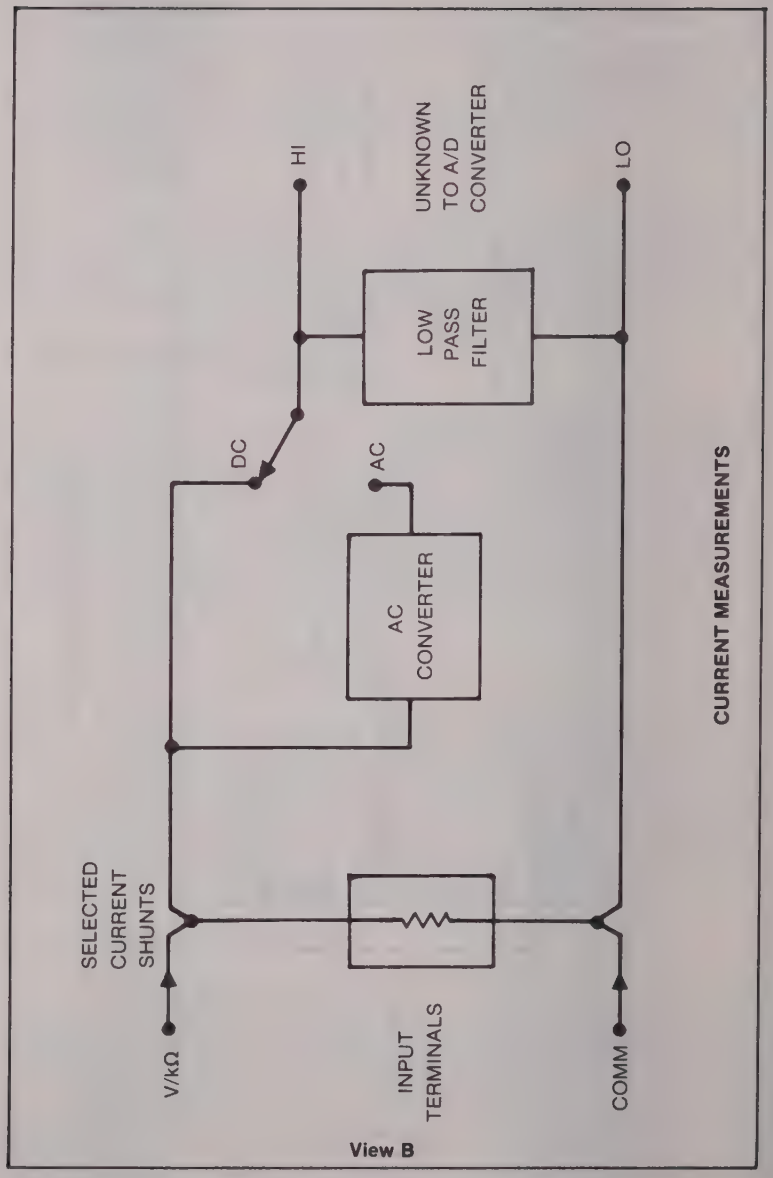


Figure 3-3. Input Signal Conditioners (cont)

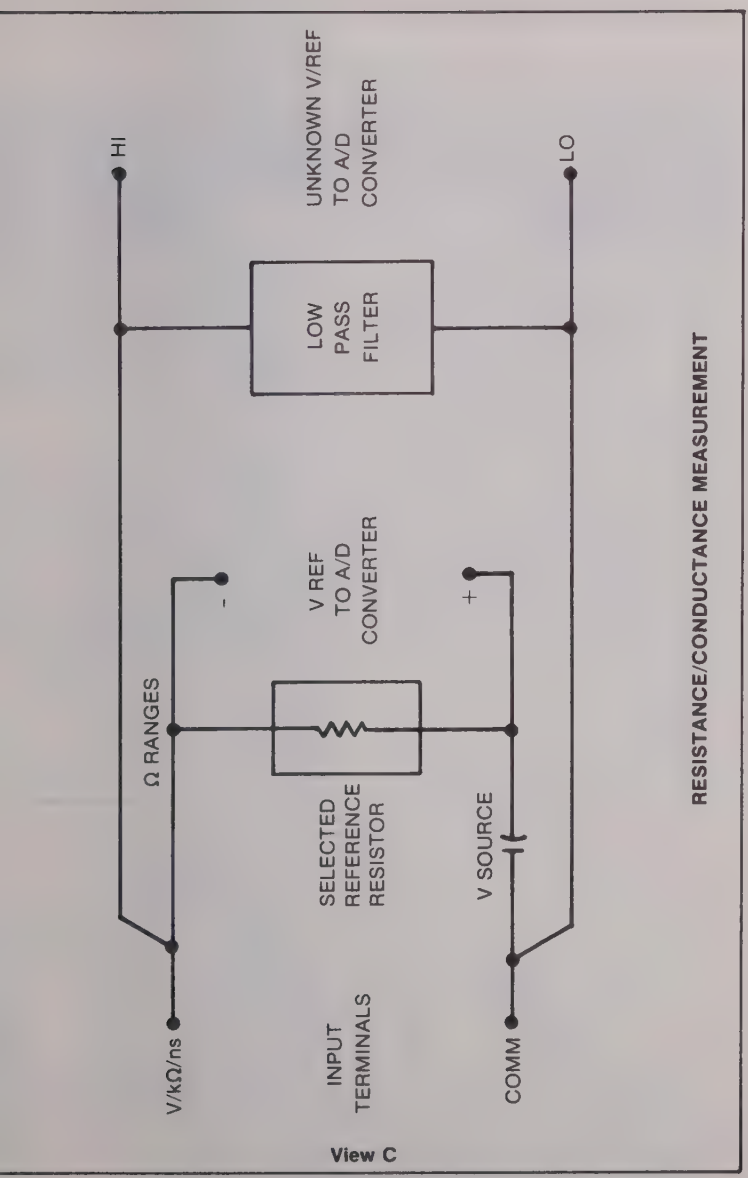


Figure 3-3. Input Signal Conditioners (cont)

3-24. RESISTANCE MEASUREMENTS

3-25. Resistance measurements are made using a ratio technique as shown in View C. When the kΩ function is selected, a simple series circuit is formed by the internal reference voltage, a reference resistor from the voltage divider (selected by range switches), and the external unknown resistor. The ratio of the two resistors is equal to the ratio of their respective voltage drops. Therefore, since the value of one resistor is known, the value of the second can be determined by using the voltage drop across the known resistor as a reference. This determination is made directly by the a/d converter.

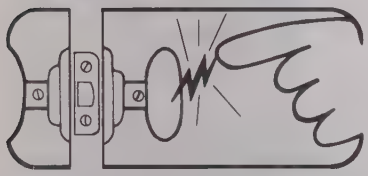
3-26. Overall operation of the a d converter during a resistance measurement is basically as described earlier in this section, with one exception. The reference voltage present during a voltage measurement is replaced by the voltage drop across the reference resistor. This allows the voltage across the unknown resistor to be read during the integrate period, and compared against the reference resistor during the read period. As before, the length of the read period is a direct indication of the value of the unknown.

3-27. CONDUCTANCE MEASUREMENTS

3-28. Conductance measurements are made using a ratio technique similar to that used in making resistance measurements. See View C. The main difference is that only two ranges are provided (200 ns and 2 ms), and the function of the range and unknown resistors in the measurement cycle is reversed. That is, the voltage drop across the range resistor is used as the unknown input during the integrate period, and the voltage across the unknown resistor is used for the reference input during the read period. As a result the display provides a reading that is the reciprocal ($1/\Omega$) of the unknown input resistance, i.e., the higher the input resistance, the lower the display reading.

static awareness

A Message From
John Fluke Mfg. Co., Inc.

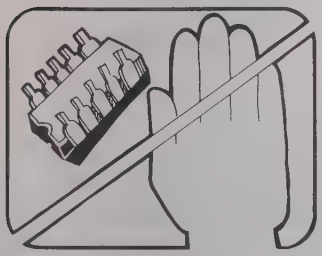


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

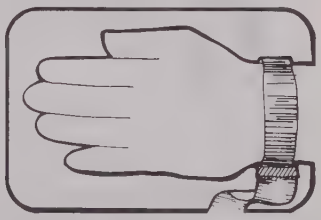
1. Knowing that there is a problem
2. Learning the guidelines for handling them
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗".

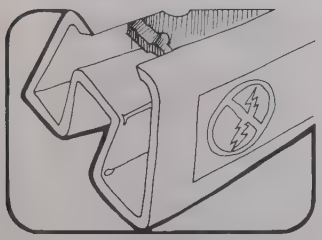
The following practices should be followed to minimize damage to S.S. devices.



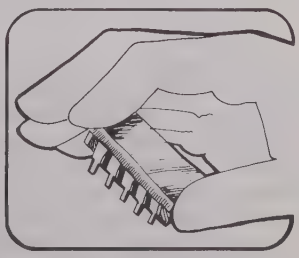
1. MINIMIZE HANDLING



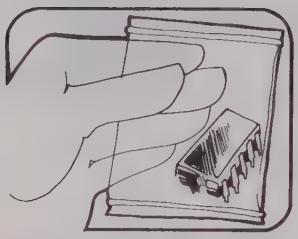
3 DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



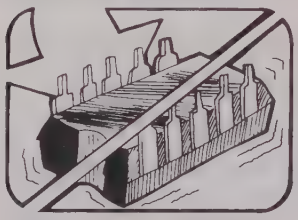
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



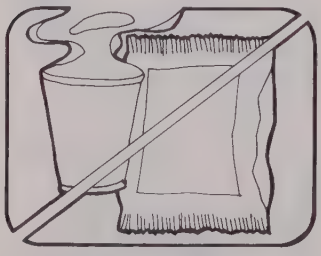
4. HANDLE S.S. DEVICES BY THE BODY



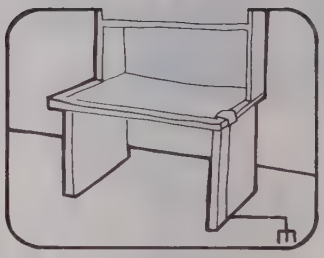
5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM IN WORK AREA



8. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

9. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

10. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Bag Size
453522	6" x 8"
453530	8" x 12"
453548	16" x 24"
454025	12" x 15"

Section 4
Maintenance

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual contains maintenance information for the Model 8020A. This includes service information, general maintenance, performance test, calibration and troubleshooting. The performance test is recommended as an acceptance test when the unit is first received, and later as a preventive maintenance tool to verify proper instrument operation. A 1-year calibration cycle is recommended to maintain the specifications given in Section 1 of this manual. The test equipment required for both the performance test and calibration is listed in Table 4-1. If the recommended equipment is not available, instruments having equivalent specifications may be used.

4-3. SERVICE INFORMATION

4-4. The 8020A is warranted for a period of 2-years upon delivery to the original purchaser. Conditions of the warranty are given at the rear of this manual.

4-5. Malfunctions that occur within the limits of the warranty will be corrected at no charge. Simply mail the instrument (postpaid) to your nearest authorized (in-warranty) Fluke Technical Service Center. A complete list of service centers is provided at the rear of this manual. Dated proof-of-purchase will be required for all in-warranty repairs.

4-6. Factory authorized service centers are also available for calibration and/or repair of instruments that are beyond their warranty period. Contact your nearest authorized Fluke Technical Service Center for a cost quotation. Ship the instrument and remittance in accordance with instructions received.

Table 4-1. List of Recommended Test Equipment

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	RECOMMENDED MODEL
	PREFERRED	
DMM Calibrator	John Fluke 5100A family	John Fluke Models 5100A, 5101A, 5102A
	ALTERNATE	
AC Calibrator	Voltage Range: 0 to 750V ac Frequency Range: 100 to 5 kHz ±0.25% Voltage Accuracy: 100 to 1 kHz ±0.1%	John Fluke Models 5200A and 5215A
DC Calibrator	Voltage Range: 0 to 1000V dc Accuracy: ±0.025%	John Fluke Model 343A
DC Current Calibrator	Current Range: 2 mA to 2A Accuracy: ±0.2%	John Fluke Model 382A
Resistor Decade or Individual Resistors	Resistance Values: 190Ω, 1.9 kΩ, 19 kΩ, 190 kΩ, 1.9 MΩ, and 10 MΩ Accuracy: ±0.025% Power Rating: ⩾1/8 watt	ESI Model DB62

4-7. GENERAL INFORMATION

4-8. Access Information

NOTE

To avoid contaminating the pcb with oil from the fingers, handle it by the edges or wear gloves. If the pcb does become contaminated, refer to the cleaning procedure given later in this section.

4-9. CALIBRATION ACCESS

4-10. Use the following procedure to access the 8020A calibration adjustments.

1. Set the power switch to OFF.
2. Disconnect test leads and battery eliminator, if attached.
3. Remove battery cover and battery from compartment.
4. Remove the three phillips-head screws from the bottom of the case.
5. Turn the instrument face-up and grasp the top cover at both sides of the input connectors. Then, pull the top cover from the unit.
6. All adjustments necessary to complete the calibration procedure are now accessible (see Figure 4-1).

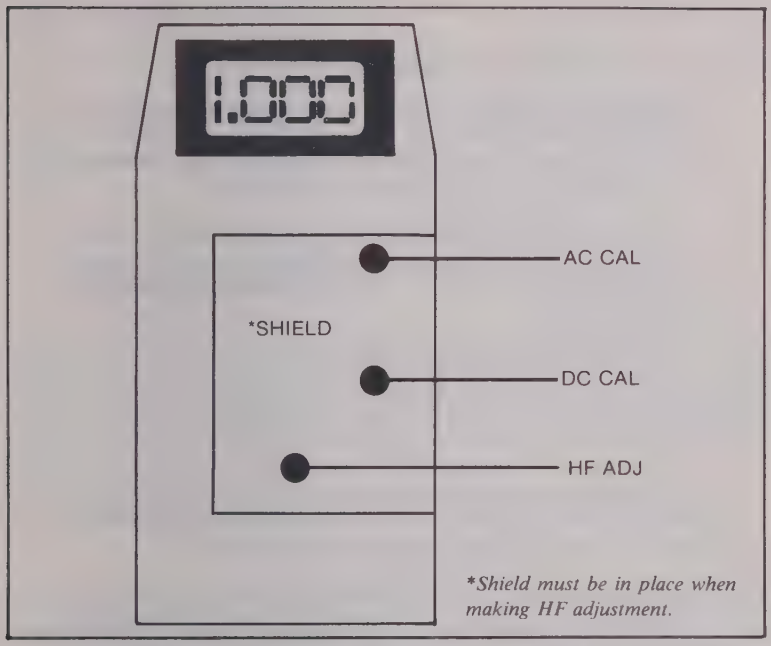


Figure 4-1. Calibration Adjustment Locations

4-11. COMPONENT/PCB ACCESS

4-12. Use the following procedure to remove the Main PCB Assembly from the case:

1. Complete the calibration access procedure.

2. Remove the screw from the shield.

3. Using your index finger, lift the lower right-hand corner of the pcb. When the pcb is freed, pull it to the right until it clears the shelf under the buttons, and then lift up.

4. To reassemble, logically reverse this procedure.

NOTE

When installing pcb, route battery-clip wires behind the post on the left-hand side of bottom case, and thread battery-clip through the battery-cover opening. Also make sure that the removable plastic lip that resides beneath the range switch pushbuttons is properly installed in the bottom case. Green power switch cap should also be mounted on the power switch.

4-13. DISPLAY ACCESS

4-14. Use the following procedure to remove/replace the liquid crystal display:

1. Remove the pcb assembly using the component/pcb access procedure.

2. Using your thumb, carefully pull one of the white display-lens snaps away from the lens. When clear, lift the lens away from the display.

CAUTION

Do not slide the lens out of the display mount. This will scratch the lens.

3. The display can now be lifted from the mount.

4. To reassemble the display, logically reverse this procedure.

NOTE

An Elastometric contact strip is located at the top of the liquid crystal display. See Figure 5-2. When assembling the display, this strip should be located between the display and the pcb interconnect cable.

4-15. LSI (U8) ACCESS

4-16. Use the following procedure to remove/replace the A/D Converter and Display Driver IC, U8.

1. Remove the pcb assembly using the component/pcb access procedure.

2. On the bottom of the pcb locate and remove the two phillips-head screws from the display assembly.

3. Lift the display assembly from the pcb to expose U8.

CAUTION

U8 is a MOS device and is subject to damage by static discharge. Observe the precautions given later in this section under troubleshoooting before attempting to remove or replace U8.

4. Use a screw driver or a reasonable substitute to rock (by prying up on each end of the IC) the IC out of its socket.

5. When installing U8 make sure all pins are lined up in the socket, and then carefully press it into place.

6. When reinstalling the LCD Bracket, be sure to line up the flex cable holes with the extensions on the bracket before tightening the bracket screws.

4-17. Cleaning

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These solutions will react with the plastic materials used in the instrument.

CAUTION

Do not get the liquid crystal display wet. Remove the Display Assembly before washing the pcb and do not install it until the pcb has been fully dried.

4-18. Clean the front panel and case with a mild solution of detergent and water. Clean dust from the circuit board with low pressure (<20 psi) dry air. Contaminates can be removed from the circuit board with demineralized water and a soft brush (remove the Display Assembly before washing, and avoid getting excessive amounts of water on the switches). Dry with clean, dry air at low pressure, and then bake at 50 to 60° C (124-140° F) for 24 hours.

4-19. Battery/Fuse Replacement

WARNING

BATTERY/FUSE REPLACEMENT SHOULD ONLY BE PERFORMED AFTER THE TEST LEADS HAVE BEEN REMOVED FROM THE INPUT JACKS, AND THE POWER SWITCH IS SET TO OFF.

4-20. Refer to Sections 1 and 2 of this manual for battery and fuse replacement procedure. Use only the recommended replacement types.

4-21. PERFORMANCE TEST

4-22. The performance test is used to compare the 8020A performance with the list of specifications given in Section 1 of this manual. It is recommended for incoming inspection, periodic maintenance, and to verify specifications. If the instrument fails any part of the test, calibration and/or repair is indicated.

4-23. Initial Procedure

4-24. Each of the individual procedures that comprise the performance test assumes that the following conditions exist.

1. The unit has been allowed to stabilize and will be tested at an ambient temperature of 23 ±5° C (73 ±9° F).

2. The fuse and battery have been checked and, if necessary, replaced.

3. The power switch has been set to ON.

4-25. Display Test

4-26. The following procedure is used to test the operation of all display digits and segments.

1. Select the 20 kΩ range. The display should be blanked with the exception of the overrange indicator (1) in the left hand column and a decimal point in the center of the display.

2. Connect a decade resistor between the V/ kΩ and COMMON input terminals.

3. Connect a decade resistor to 10 kΩ and verify a display of 10.00 ±3 digits.

4. Sequentially increase the resistance in 1.11 kΩ steps and verify the operation of each digit and its segments.

5. Disconnect the decade resistor at the input terminals, and select the 2000 kΩ range. A decimal point should not be displayed.

6. Sequentially select the 200, 20 and 2 kΩ range. The decimal point should appear in the tenths, hundredths, and thousandths position, respectively.

4-27. Resistance/Conductance Test

4-28. The operation and accuracy of the resistance and conductance ranges are tested in the following procedure.

1. Connect the decade resistor between the V/kΩ and COMMON input terminals.

2. Refer to Table 4-2, and select the range and input conditions specified in step 1. Verify that the display reading is within the limits shown.

3. Execute and verify steps 2 through 8 of Table 4-2, using the procedure described in step 2.

Table 4-2. Resistance/Conductance Check

STEP	RANGE	JOHN FLUKE 5100A/5101A/5102A		ESI MODEL DB62	
		INPUT RESISTANCE	DISPLAY READING	INPUT RESISTANCE	DISPLAY READINGS
1	200Ω	Short	00.0 to 00.2	Short	00.0 to 00.2
2	2 kΩ	Short	0.000 to 0.001	Short	.000 to 0.001
3	200Ω	190Ω	189.3 to 190.7	100Ω	99.5 to 100.5
4	2 kΩ	1.9 kΩ	1.897 to 1.903	1 kΩ	.998 to 1.002
5	20 kΩ	19 kΩ	18.97 to 19.03	10 kΩ	9.98 to 10.02
6	200 kΩ	190 kΩ	189.7 to 190.3	100 kΩ	99.8 to 100.2
7	2000 kΩ	1900 kΩ	1897 to 1903	1000 kΩ	998 to 1002
8	20 MΩ	10 MΩ	19.80 to 10.20	10 MΩ	9.80 to 10.20
9	200 nS	10 MΩ	97.0 to 103.0	10 MΩ	97.0 to 103.0
10	200 nS	Open	01.0 to 00.0	Open	01.0 to 00.0

4-29. DC Voltage Test

4-30. Use the following procedure to check the accuracy and overall operation of the dc voltage ranges.

WARNING

CONNECT THE GROUND/COMMON/LOW SIDE OF THE VOLTAGE CALIBRATOR TO COMMON ON THE 8020A.

1. Set the dc voltage calibrator for a zero volt output.

2. Connect the calibrator output to the V/kΩ and COMMON input terminals of the 8020A (calibrator ground/common/low to 8020A).

3. With reference to Table 4-3, select the 8020A voltage range given in step 1, and set the calibrator output to the corresponding 8020A input voltage. Verify that the display reading is within the limit shown.

4. Execute and verify steps 2 through 7 of Table 4-3, using the procedure described in step 3.

Table 4-3. DC Voltage Test

STEP	VOLTAGE RANGE	INPUT VOLTAGE, DC	DISPLAY READING
1	200 mV	+190.0 mV	189.7 to 190.3
2	200 mV	-190.0 mV	-189.7 to -190.3
3	2V	0.0V	-.001 to .001
4	2V	+1.9V	1.897 to 1.903
5	20V	+19V	18.97 to 19.03
6	200V	+190V	189.7 to 190.3
7	1000V	+1000V	998 to 1002

4-31. AC Voltage Test

4-32. The ac voltage ranges are checked for accuracy and operation using the following procedure.

WARNING

CONNECT THE GROUND/COMMON/LOW SIDE OF THE AC CALIBRATOR TO COMMON ON THE MODEL 8020A.

1. Set the ac calibrator for a zero volt ac output.

2. Connect the calibrator output to the V/kΩ and COMMON input terminals for the 8020A (calibrator ground/common/low to 8020A COMMON).

3. With reference to Table 4-4, select the 8020A voltage range given in step 1, and set the calibrator output to the corresponding 8020A input voltage and frequency. Verify that the display reading is within the limits shown.

4. Execute and verify steps 2 through 12 of Table 4-4, using the procedure described in step 3.

Table 4-4. AC Voltage Test

STEP	VOLTAGE RANGE	INPUT		DISPLAY READING	
		VOLTAGE	FREQ.		
1	200 mV	Short	-	00.0 to 00.2	
2	200 mV	190 mV	100 Hz	188.4 to 191.6	
3	200 mV	19 mV	100 Hz	18.7 to 19.3	
4	200 mV	190 mV	5 kHz	180.0 to 199.9	
5	2V	1.9V	5 kHz	1.800 to 1.999	
6	2V	1.9V	100 Hz	1.884 to 1.916	
7	20V	19V	100 Hz	18.84 to 19.16	
8	20V	19V	5 kHz	18.00 to 19.99	
9	200V	100V	2 kHz	98.2 to 101.8	1
10	200V	190V	100 Hz	188.4 to 191.6	
11	750V	750V	100 Hz	741 to 759	
12	NO TEST				
9	200V	190V	2 kHz	186.9 to 193.1	2
10	200V	190V	100 Hz	188.4 to 191.6	
11	750V	750V	100 Hz	741 to 759	
12	750V	750V	1 kHz	741 to 759	

1 Perform if using John Fluke 5100A/5101A/5102A.
2 Perform if using alternate equipment listed in Table 4-1.

4-33. DC Current Test

4-34. The following procedure is used to check the operation and accuracy of the DC current ranges.

1. Set the output of the dc current source to zero mA.

2. Connect the output of the current source to the mA and COMMON input terminals on the 8020A.

3. With reference to Table 4-5, select the 8020A current range indicated in step 1, and set the calibrator output to provide the corresponding 8020A input current. Verify that the display reading is within the limits shown.

4. Execute and verify steps 2 through 4 of Table 4-5, using the procedure described in step 3.

Table 4-5. DC Current Test

STEP	CURRENT RANGE	INPUT CURRENT, DC	DISPLAY READING
1	2 mA	+1.9 mA	1.885 to 1.915
2	20 mA	-19 mA	-18.85 to 19.15
3	200 mA	+190 mA	188.5 to 191.5
4	2000 mA	+1900 mA	1885 to 1915

4-35. CALIBRATION

4-36. Under normal operating conditions, the 8020A should be calibrated once a year to maintain the specifications given in Section 1 of this manual. If instrument repairs have been made or if the unit fails the performance test, immediate calibration is indicated. Equipment required for calibration is given in Table 4-1. If the necessary equipment is not available, your nearest authorized Fluke Technical Service Center will be happy to help. A list of these service centers, as well as shipping information, is given at the back of this manual.

4-37. Use the following procedure to calibrate the 8020A.

NOTE

This procedure assumes an ambient temperature of 23 ±2° C (70 to 77° F) and a relative humidity of less than 80%. The temperature of the unit should be allowed to stabilize for at least 30 minutes before calibration begins.

1. Remove the top cover from the 8020A using the access procedure given earlier in this section.

2. Set the 8020A power switch to ON and select the 200 mV DC range.

3. Set the output of the dc calibrator to +190.0 mV and connect it to the 8020A input terminals; + to V/kΩ, and – to COMMON.

4. Adjust the DC CAL pot (R6), as shown in Figure 4-1, for a display of 190.0 or 190.1. (Use a plastic adjustment tool or a common plastic screw driver for all adjustments.)

5. Disconnect the dc calibrator from the 8020A input terminals.

6. Select the 200 mV AC range on the 8020A.

7. Set the output of the ac calibrator to 190 mV at 100 Hz, and connect it to the 8020A input terminals; V/kΩ and COMMON.

8. Adjust the AC CAL pot (R4) for a display of 190.0 (an occasional flash of ±1 digit is acceptable).

9. Select the 2V ac range on the 8020A and set the ac calibrator output to 1.9V at 5 kHz.

10. Adjust the HF ADJ (C1) for a display of 1.895 to 1.905.

11. Execute the performance test given earlier to ensure that all fixed range resistors and other non-adjustable components are operating within their specified limits.

4-38. TROUBLESHOOTING

CAUTION

Static discharge can damage MOS components contained in the 8020A.

4-39. When troubleshooting or repairing the 8020A use the precautions listed on the Static Awareness sheet to prevent damage from static discharge. Never remove, install or otherwise connect or disconnect components without first turning the 8020A power switch to OFF.

4-40. A troubleshooting guide for the 8020A is given in Table 4-6. To properly use the guide complete the performance test given earlier in this section and note any discrepancies. Then locate the heading of the procedure in question in the Test and Symptom column (Table 4-6). Under that heading isolate the symptom that approximates the observed malfunction. Possible causes are listed to the right of the selected symptom. Details necessary to isolate a particular cause can be derived from the theory of operation in Section 3 and the schematic diagram in Section 7.

Table 4-6. Troubleshooting Guide

TEST AND SYMPTOM	POSSIBLE CAUSE
INITIAL PROCEDURE	
BT is displayed when unit is turned on.	Low battery, Q2, U7, U8.
Display blank.	Dead battery, power switch, VR2, shorted, U8.
DISPLAY TEST	
One or more segments will not light through entire test.	Display interconnect, display, or A/D Converter U8.
Decade inoperative or one or more segments always lit.	U8.

TEST AND SYMPTOM	POSSIBLE CAUSE
Improper decimal point indication.	Range switches, U6, U7, or display. (Check signals at U7 to isolate.)
Minus sign improperly displayed.	U8.
Display lit but does not respond to changes in input.	Reference VR1, crystal Y1, A/D Converter U8.
RESISTANCE/CONDUCTANCE TEST	
Displayed reading is out of tolerance on at least one but not all ranges.	Range resistor U1.
Readings are noisy on all ranges	Thermistor RT1.
Readings are out of tolerance on high ohms.	RV1, RV2, RV3, RV4 overheated from severe overload.
Residual reading with test leads open.	PCB is contaminated (see cleaning procedure, Section 4).
DC VOLTAGE TEST	
Display reading is out of tolerance on 200 mV range.	Out of calibration (DC), Vref (VR1) in error, U5, U8, S1.
Readings are out of tolerance on all ranges except 200 mV.	Range resistor U1, U2, U3.
AC VOLTAGE TEST	
Displayed reading is out of tolerance on 200 mV range.	Out of calibration (AC), AC converter defective.
2V range is out of tolerance with 1.9V, 4 kHz input.	HF adjust (C1) out of calibration.
Readings out of tolerance on all ranges except 200 mV.	U1.
DC CURRENT TEST	
Input does not affect display.	Fuse F1 open, CR1, CR2.
Displayed reading is out of tolerance on one or more ranges.	If 2000 mA and 200 mA ranges are okay, U2 is defective. Otherwise U3 is defective.
CALIBRATION	
DC CAL pot at limit.	VR1, U5 or R6.
AC CAL pot at limit.	U4, CR5, CR6, R4, AR1, dc calibration.
HF adjust at limit.	S3D, U1, C1, shield not installed.

Section 5
List of Replaceable Parts

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. A similar parts listing for each of the Options will be found in Section 6. Components are listed alphanumerically by assembly. Both electrical and mechanical components are listed by reference designation. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

1. Reference Designation.
2. Description of each part.
3. FLUKE Stock Number.
4. Federal Supply Code for Manufacturers. (See Table 5-4.)
5. Manufacturer's Part Number.
6. Total Quantity per assembly or component.
7. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized

representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

1. Quantity.
2. FLUKE Stock Number.
3. Description.
4. Reference Designation.
5. Printed Circuit Board Part Number.
6. Instrument Model and Serial Number.

CAUTION

Indicated devices are subject to damage by static discharge.

Table 5-1. 8020A Final Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A	8020A, FINAL ASSEMBLY FIGURE 5-1						
A1	Ⓐ PCB ASSEMBLY FIGURE 5-2	ORDER	ONLY	REPLACEABLE PARTS	1		
A2	CASE ASSEMBLY				1		
	USA SOURCE	515452	89536	515452			
	EUROPEAN SOURCE	467365	89536	467365			
	SEE FIGURE 5-1						
BT1	BATTERY, 9-VOLT (NOT SHOWN)	446823	89536	446823	1		1
H1	SCREW, PHP, 2-56 X 3/16	272906	73734	19001	1		
H2	SCREW, PHP, THREAD FORMING	447953	89536	447953	3		
MP1	TEST LEADS (NOT SHOWN)	506428	89536	506428	1		
MP2	BUTTON, POWER SWITCH	456491	89536	456491	1		
MP3	CASE, CARRYING (8020A-8020)	454389	89536	454389	1		
	MANUAL, INSTRUCTION	459339	89536	459339	1		
	GUIDE CARD, OPERATOR	515817	89536	515817	1		

1 INSTALLED BY CUSTOMER.
SEE SECTION 1.

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A2	CASE ASSEMBLY				REF		
	SEE FIGURE 5-1						
	USA	515452	89536	515452			
	EUROPEAN	505214	89536	505214			
MP1	SHOCK ABSORBER	428441	89536	428441	1		
MP2	BAIL, TILT	496596	89536	496596	1		
MP3	CASE, PLASTIC, BOTTOM				1		
	USA	450700	89536	450700			
	EUROPEAN	454587	89536	454587			
MP4	CASE, PLASTIC, TOP (8020A-2014)	515445	89536	515445	1		
MP5	COVER, BATTERY	450718	89536	450718	1		
MP6	DECAL, FRONT PANEL	507798	89536	507798	1		
MP7	DECAL, WARNING (NOT SHOWN)	428938	89536	428938	1		
MP8	FLANGE, SWITCH	455881	89536	455881	1		
MP9	SHIELD	508101	89536	508101	1		
MP10	SPACER, CASE	458588	89536	458588	2		

Table 5-2. A2 Case Assembly

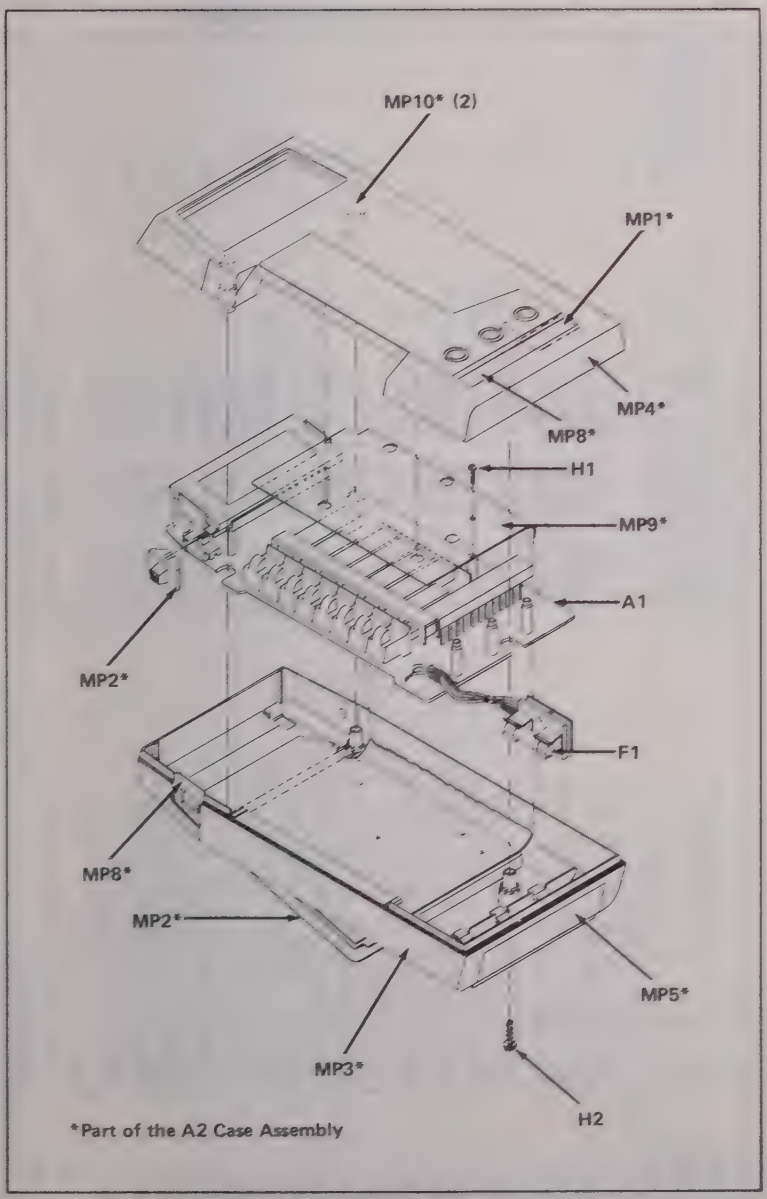


Figure 5-1. 8020A Final Assembly

Table 5-3. A1 8020A PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CODE
A1	Ⓜ 8020A PCB ASSEMBLY				REF		1
	FIGURE 5-2 (8020A-4001)						
AR1	IC, DUAL, OP AMP	418566	89536	418566	1	1	
C1	CAP, VAR, 0.25-1.5 PF, 2000V	218206	72982	530.000	1		
C2	CAP, MYLAR, 0.022 UF +/-10%, 1000V	448183	89536	448183	1		
C3	CAP, TA, 10 UF +/-20%, 15V	193623	56289	196D106X0015KA1	2		
C4	CAP, CER, 33 PF +/-2%, 100V	354852	80031	2222-631-10339	1		
C5	CAP, MYLAR, 0.1 UF +/-10%, 100V	393439	73445	C280MAH/A100K	1		
C6	CAP, PLLY PROPL. 0.047 UF +/-10%, 100V	446773	89536	446773	2		
C7	CAP, CER, 500 PF +/-10%, 500V	105692	71590	2DDH60N501K	2		
C8	CAP, POLY PROPL. 0.047 UF +/-10%, 100V	446773	89536	446773	REF		
C9	CAP, POLY PROPL. 0.1 UF +/-10%, 100V	446781	89536	446781	1		
C10	CAP, MYLAR 0.22 UF +/-10%, 100V	436113	73445	C280MAH/A220K	1		
C11	CAP, TA, 10 UF +/-20%, 15V	193623	56289	196D106X0015KA1	REF		
C12	CAP, CER, 500 PF +/-10%, 500V	105692	71590	2DDH60N501K	REF		
CR1	DIODE, SI, RECTIFIER	347559	05277	1N5400	2	1	
CR2	DIODE, SI, RECTIFIER	347559	05277	1N5400	REF		
CR3	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	4	1	
CR4	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR5	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
CR6	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	REF		
F1	FUSE, 2 AMP/250V				1	5	
	AMERICAN	376582	71400	AGX2			
	EUROPEAN	460972	89536	460972			
H1	SCREW, THREAD-FORMING, 3/8 HI-LO TYPE	448456	89536	448456	2		

Table 5-3. A1 8020A PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
J1	CONNECTOR, ELASTOMERIC	453092	89536	453092	1		
J4	CONNECTOR, DC POWER	423897	89536	423897	1		
J5	CONTACT ASSEMBLY, BATTERY/FUSE				1		
	AMERICAN VERSION	453910	89536	453910			
	METRIX VERSION	454413	89536	454413			
MP1	BRACKET, DISPLAY (U9), MOUNTING	450734	89536	450734	1		
MP2	DISPLAY, INTERCONNECT	453746	89536	453746	1		
MP3	DISPLAY, LENS, PLASTIC	450759	89536	450759	1		
MP4	INSERT, RUBBER, DISPLAY BRACKET	453787	89536	453787	2		
MP5	PUSHBUTTON, GREY, RANGE				6		
	IF SWITCH ASSEMBLY IS WHITE, ORDER	450767	89536	450767			
	IF SWITCH ASSEMBLY IS BLUE, ORDER	459040	89536	459040			
MP6	PUSHBUTTON, WHITE, FUNCTION				2		
	IF SWITCH ASSEMBLY IS WHITE, ORDER	450809	89536	450809			
	IF SWITCH ASSEMBLY IS BLUE, ORDER	450957	89536	459057			
Q1	XSTR, SI, NPN	483859	89536	483859	2	1	
Q2	XSTR, SI, NPN	483859	89536	483859	REF		
R1	RES, COMP, 100K +/-10%, 1W	109397	01121	GB1041	1		
R2	RES, WW, 1K +/-10%, 2W	474080	89536	474080	1		
R3	RES, COMP, 2.2M +/-5%, 1/4W	198390	01121	CB2255	1		
R4	RES, VAR, 300 +/-10%	447722	89536	447722	1	1	
R5	RES, COMP, 1M +/-10%, 1W	109793	01121	GB1051	1		
R6	RES, VAR, 500 +/-10%	447730	89536	447730	1	1	
R8	RES, COMP, 220K +/-5%, 1/4W	160937	01121	C92245	1		
R9	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	1		

Table 5-3. A1 8020A PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
RT1	THERMISTOR, 1K +/-40%	446849	89536	446849	1		
RV1	VARISTOR, 430V +/-10%	447672	09214	V150LAX827	4	1	
RV2	VARISTOR, 430V +/-10%	447672	09214	V150LAX827	REF		
RV3	VARISTOR, 430V +/-10%	447672	09214	V150LAX827	REF		
RV4	VARISTOR, 430V +/-10%	447672	09214	V150LAX827	REF		
S1-S8	SWITCH ASSEMBLY, PUSHBUTTON				1	1	
	IF ASSEMBLY IS WHITE, ORDER	453050	89536	453050			
	IF ASSEMBLY IS BLUE, ORDER	453647	89536	453647			
S9	SWITCH, SLIDE, SPDT	453365	89536	453365	1	1	
U1	RESISTOR NETWORK (INPUT DIVIDER)	513565	89536	513565	1	1	
U2	RESISTOR NETWORK	447706	89536	447706	1	1	
U3	RESISTOR NETWORK	435727	89536	435727	1	1	
U4	RESISTOR NETWORK	447698	89536	447698	1	1	
U5	RESISTOR NETWORK	447680	89536	447680	1	1	
U6	RESISTOR NETWORK	447714	89536	447714	1	1	
U7	⊛IC, MOS, QUAD, 2-INPUT OR GATE	355222	02735	CD4030AE	1	1	
U8	⊛IC, MOS, A/D CONVERTER, DISPLAY DRIVER	486464	89536	486464	1	1	
U9	IC, LIQUID CRYSTAL DISPLAY, 3 1/2 DIGITS	453100	89536	453100	1	1	
VR1	REFERENCE, LOW VOLTAGE, 1.22V	508259	89536	508259	1		
VR2	DIODE, ZENER, 12V	113456	07910	1N963A	1		
XU8	SOCKET, IC, DIL, 40-PIN	429282	09922	DILB40P-108	1		
Y1	CRYSTAL, 3.2 MHZ	460550	89536	460550	1		

⊛ ASSEMBLY IS NOT PROCURABLE AT THIS LEVEL.

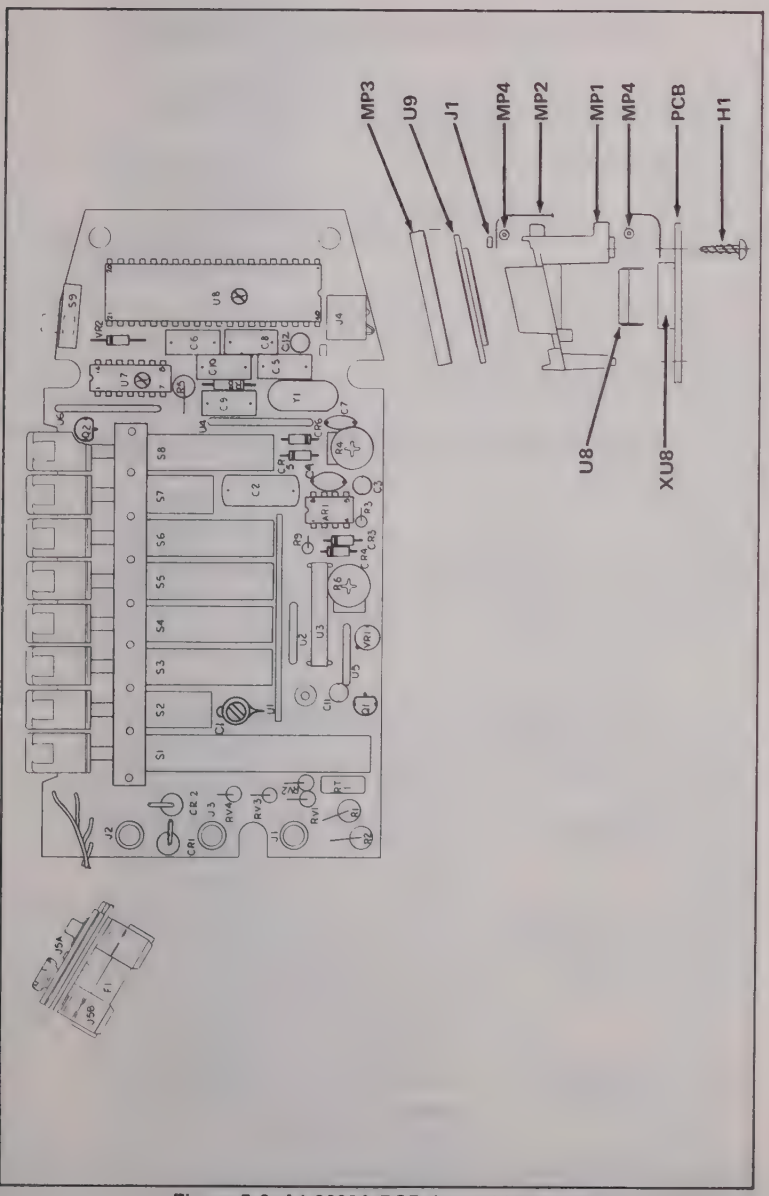


Figure 5-2. A1 8020A PCB Assembly (cont)

Table 5-4. Federal Supply Codes for Manufacturers

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

02735
RCA - Corp - Solid State Div.
Sommerville, New Jersey

04713
Motorola Inc. Semiconductor Products
Phoenix, Arizona

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

09214
G.E. Co. Semiconductor Products Dept.
Power Semiconductor Products OPN Sec.
Auburn, New York

56289
Sprague Electric Co.
North Adams, Massachusetts

71400
Bussmann Mfg.
Div. of McGraw-Edison Co.
St. Louis, Missouri

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73445
Amperex Electronic Corp.
Hicksville, LI, New York

80031
Electro-Midland Corp., Mepco Div.
A North American Phillips Co.
Morristown, New Jersey

89536
Fluke, John Mfg. Co., Inc.
Seattle, Washington

91506
Augat Inc.
Attleboro, Massachusetts

Table 5-5. Fluke Technical Service Centers (U.S. and Canada)

United States

CALIFORNIA
Burbank
Fluke Technical Center
2020 N. Lincoln St.
Zip: 91504
Tel. (213) 849-4641

ILLINOIS
Rolling Meadows
Fluke Technical Center
1400 Hicks Road
Zip: 60008
Tel. (312) 398-5800

NEW JERSEY
Clifton
Fluke Technical Center
460 Colfax Ave.
Zip: 07013
Tel. (201) 778-1339

Canada

ONTARIO
Mississauga
Allan Crawford Assoc. Ltd.
Fluke Technical Center
6503 Northam Drive
Zip: L4V 1J5
Tel. (416) 678-1500

Table 5-6. Sales and Service Locations (International)

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Fluke (Nederland) B.V.
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Zevenheuvelenweg 53
Tilburg, Netherlands.

EUROPE

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*Walter Rekirsch Elektronische Gerate GmbH & Co. Vertrieb KG
Liechtensteinstrasse 97/6
A-1090 Vienna, Austria
Tel. (222) 347646-0

BELGIUM
*C. N. Rood S/A
37 Place de Jamblinne de Meux
B-1040 Brussels, Belgium
Tel. (02) 27352135

CYPRUS
Chris Radiovision Ltd.
P.O. Box 1989
Nicosia, Cyprus
Tel. 66121

DENMARK
*Tage Olsen A/S
Ballerup Byveg 222
DK-2750 Ballerup
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Tel. 211-450831

*Fluke (Deutschland) GmbH
8000 Munich 80
Vertriesburo Bayern
Rosenheimer Strasse 139
West Germany
Tel. 089-404061

GREECE
*Hellenic Scientific Representations Ltd.
11 Vrassida Street
Athens 612, Greece
Tel. (021) 7792320

ITALY
*Sistrel S.p.A.
Via Giuseppe Armellini No. 39
00143 Rome, Italy
Tel. (06) 5915551

*Sistrel S.p.A.
Via Timavo 66
20099 Sesto S. Giovanni (Milan)
Italy
Tel. (02) 2476693

Table 5-6. Sales and Service Locations (International) (cont)

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Cort van der Lindenstraat
11-13
Rijswijk ZH2280AA
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Tel. (070) 996360

NORWAY
*Morgenstierne & Co. A/A
Konghellegate 3
P.O. Box 6688, Rodelokka
Oslo 5, Norway
Tel. (02) 356110

PORTUGAL
*Equipamentos
De Laboratorio Ltda.
P.O. Box 1100
Lisbon 1, Portugal
Tel. (019) 976551

SPAIN
*Hispano Electronica S.A.
Poligono Industrial Urtinsa
Apartado de Correos 48
Alcorcon (Madrid), Spain
Tel. 09-341-6194108

SWEDEN
*Teleinstrument AB
P.O. Box 490
S-162 Vallingby-4
Sweden
Tel. (08) 380370

SWITZERLAND
*Traco Electronic AG
Jenatschstrasse 1
8002 Zurich, Switzerland
Tel. (01) 2010711

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*Erkman Electronik Aletler
Necatibey Cad 92/2
Karakoy/Istanbul
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*Fluke International Corp.
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Lotus Engineering Organisation
P.O. Box 1252
Cairo, Egypt
Tel. 71617

IRAN
*Irantronics Company Ltd.
20 Salm Road, Roosevelt Ave.
Tehran, Iran
Tel. 828294

ISRAEL
*R.D.T. Electronics
Engineering Ltd.
46, Sokolov Street
Ramat Hasharon 47235, Israel
Tel. 482311

JORDAN
Trading & Agricultural
Development Co.
P.O. Box 567
Amman, Jordan
Tel. 23052

KUWAIT
Tareq Company
P.O. Box Safat 20506
Kuwait, Arabian Gulf
Tel. 436100

LEBANON
Mabek
P.O. Box 11-3823
Beirut, Lebanon
Tel. 252631

MOROCCO
Mainvest
Residence Moulay Ismail
Bat.C Boulevard
Moulay Slimane, Rabat,
Morocco
Tel. 276-64

SAUDI ARABIA
Electronic Equipment
Marketing Est.
P.O. Box 3750
Riyadh, Saudi Arabia
Tel. 32700

SYRIA
Mabek Electronics
C/O Messers G. Ghazzi
P.O. Box 4238
Damascus, Syria

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Customers in the following countries: Bulgaria, Czechoslovakia, Hungary, Poland, Romania, U.S.S.R. and Yugoslavia, contact: Amtest Associates Ltd., P.O. Box 55, Addlestone, Surrey, KT 15 1DU, England, Tel. (0932) 52121

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Elmeasco Instruments Pty. Ltd.
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BANGLADESH
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97 - Gulshan Ave., Gulshan
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BOLIVIA
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Casilla 7295
La Paz, Bolivia
Tel. 40962

BRAZIL
*Arotec S.A.
Industrial e Comercio
Av. Pacaembu 811
Sao Paulo S.P., Brazil
Tel. (67) 2393

*Arotec S.A.
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Grupo 1309
Rio de Janeiro - R. J., Brazil

ARGENTINA
*Coasin S.A.
Virrey del Pino 4071
Buenos Aires, Argentina
Tel. 523185

Table 5-6. Sales and Service Locations (International) (cont)

CHILE
*Intronica Chile Ltda.
Casilla 16228
Manuel Montt 024-Of. D
Santiago 9, Chile
Tel. 44940

COLOMBIA
Coasin Ltda.
Carrera 13, No. 37-37, Of. 407
Ap. Aereo 29583
Bogota DE, Colombia
Tel. 285-0230

ECUADOR
*Proteco Coasin CIA, Ltda.
Edifica "Jerico"
Ave. 12 de Octubre
No. 2285 y Ave. Orellana
(Planta Baja)
Quito, Ecuador
Tel. 529-684

HONG KONG
*Gilman & Co., Ltd.
P.O. Box 56
Hong Kong
Tel. 794266

ICELAND
Kristjan O. Skagfjord Ltd.
P.O. Box 906
Reykjavik, Iceland
Tel. 24120

INDIA
*Hinditron Services Pvt. Ltd.
69/A.L. Jagmohandas Marg
Bombay 400 006, India
Tel. 365344

*Hinditron Services Pvt. Ltd.
412 Raj Mahal Vilas Extn.
Bangalore 560 006, India
Tel. 33139

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*P.T. DWI Tunggal Jaya Sakti
Sangga Buana Bldg., 1st Floor
J1 Senen Raya 44, P.O. Box 4435
Jakarta, Indonesia
Tel. 367390

P.T. DWI Tunggal Jaya Sakti
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Bandung, Indonesia

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Tel. (045) 471-8811

*John Fluke Mfg. Co., Inc.
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Midori-ku
Yokohama 226, Japan
Tel. (045) 473-5425
Tlx: 3823-666 FLUKJP J

KENYA
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P.O. Box 30070
Nairobi, Kenya
East Africa
Tel. 331955

KOREA
*Electro-Science Korea Co.
C.P.O. Box 8446
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Chongro-ku
Seoul, Korea
Tel. 261-7702

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East Malaysia
Tel. 54082

O'Connor's (Pte) Ltd.
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Petaling Jaya, Selangor
West Malaysia
Tel. 51563

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*C.J. Christensen S.A. de C.V.
Instrumentos Electronicos
de Medicion
Melchor Ocampo 150-8
Mexico 4, D.F., Mexico
Tel. (905) 535-2258

NEW ZEALAND
*W & K McLean Ltd.
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Auckland, New Zealand
Tel. 587-037

NIGERIA
Mofat Engineering Co., Ltd.
P.O. Box 6369
Lagos, Nigeria

PAKISTAN
Pak International Operations
505 Muhammadi House
McLeod Road
P.O. Box 5323
Karachi, Pakistan
Tel. 221127

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*Importaciones
y Representaciones
Electronicas S.A.
Avda, Franklin D. Roosevelt 105
Lima 1, Peru
Tel. 288650

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*O'Connor's (Pte) Ltd.
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Singapore 5, Singapore
Tel. 637944

SOUTH AFRICA
*Fluke S.A. (Pty) Ltd.
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Bramley 2018
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***Technical Service Available**

Section 6
Option & Accessory Information

6-1. INTRODUCTION

6-2. This section of the manual contains information concerning the accessories available for use with the Model 8020A Digital Multimeter (there are not options available at this time). Each accessory, as shown in Figure 6-1, is described in general terms under a separate major heading containing the accessory model number. The depth of detail is intended to give the prospective user and adequate first acquaintance with the features and capabilities of each accessory. Additional information, when necessary, is supplied with the accessory.

6-3. DELUXE CARRYING CASE (C90)

6-4. The C90 Deluxe Carrying Case is a pliable, vinyl, zipper-closed pouch that provides in-field-transport protection for the 8020A, as well as convenient storage locations for test leads, operator's guide and other small accessories. A finger- or belt-loop is included on the case as a carrying convenience.

6-5. TEMPERATURE PROBE (80T-150)

6-6. Introduction

6-7. The 80T-150 Temperature Probe converts the instrument into a direct-reading (1 mV dc/°) °C or °F thermometer. It is ideally suited for surface, ambient and liquid measurement, and lends itself easily to a wide range of design, troubleshooting and evaluation applications. A rugged, fast-responding probe-tip with a 350V dc standoff makes the 80T-150 one of the most versatile and easy-to-use temperature probes available.

6-8. Specifications

Range (°C/°F) (field selectable by internal jumpers): 50°C to +150°C or 58°F to 302°F.
Accuracy: ±1°C (1.8°F) from 0°C to 100°C, decreasing linearly to ±3°C (5.4°F) at −50°C and +150°C.
Resolution: 0.1°C on 200 mV range.
Voltage Standoff: 350V dc or peak ac.
Power: Internal disposable battery; 1,000 hours of continuous use.

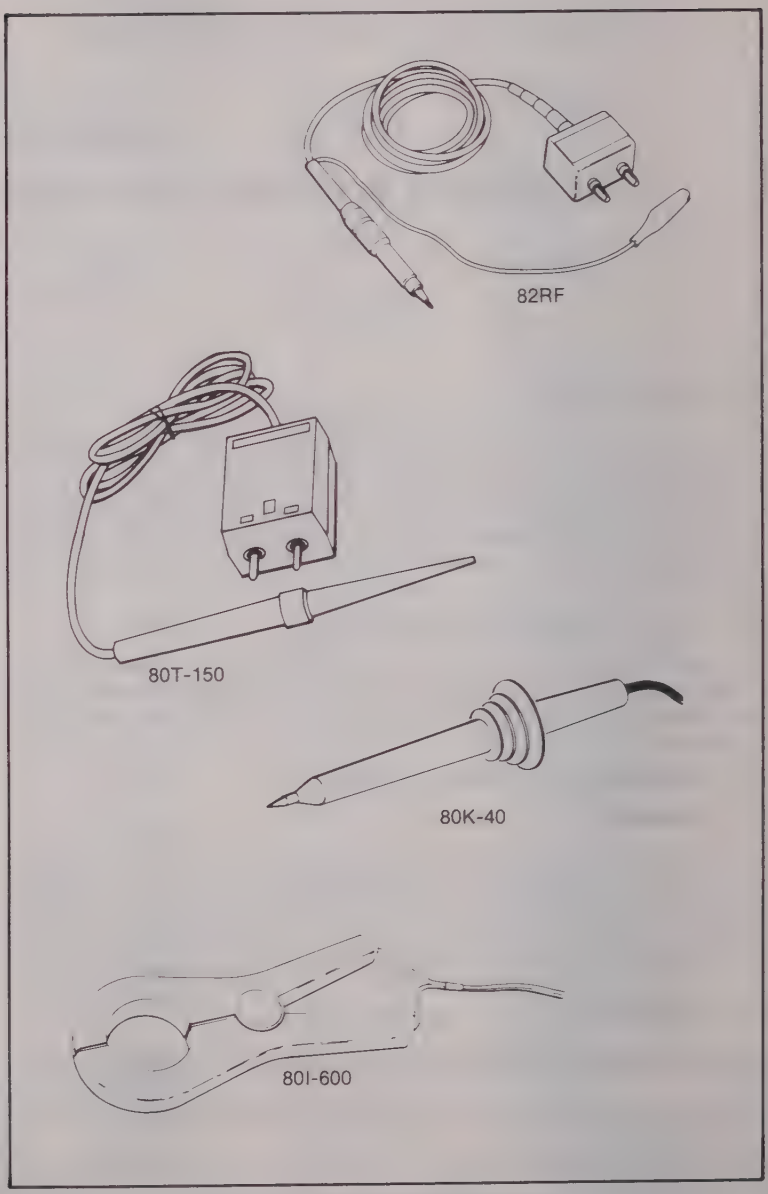

Figure 6-1. Model 8020A Accessories

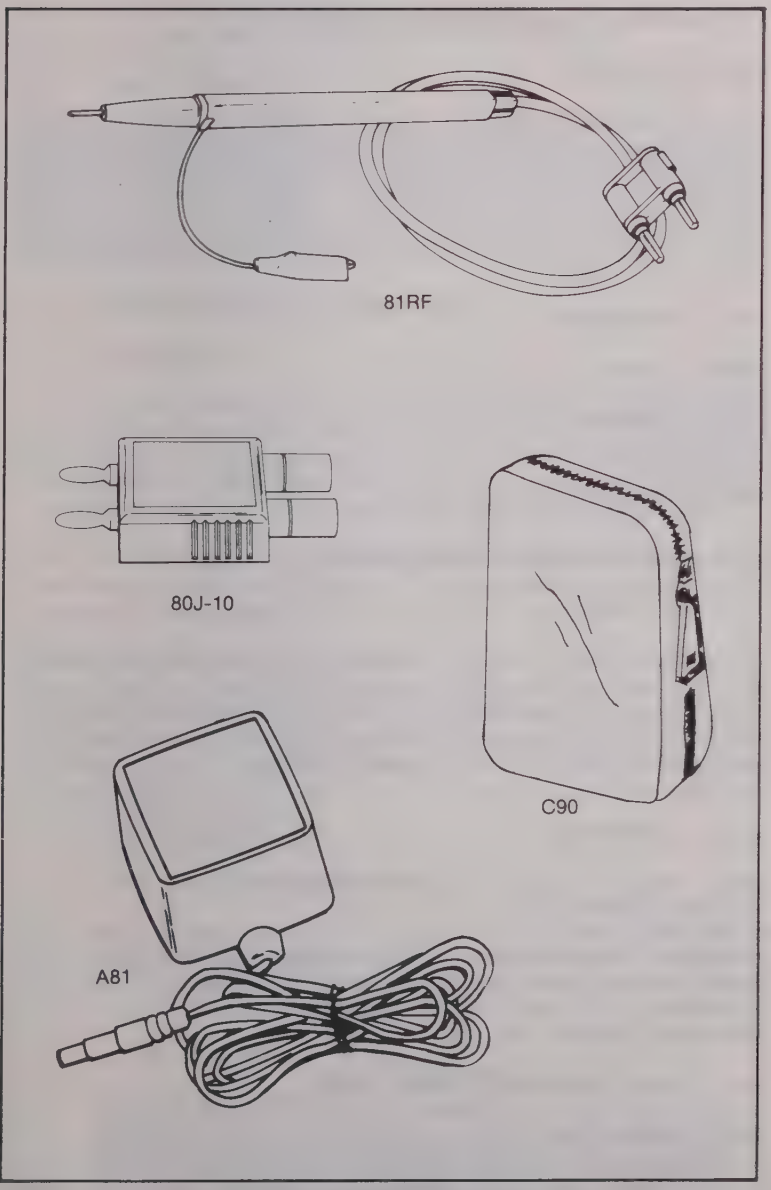

Figure 6-1. Model 8020A Accessories (cont)

6-9. CURRENT TRANSFORMER (80I-600)

6-10. Introduction

6-11. The Model 80I-600 extends the maximum 2A ac current measuring capability of the instrument up to a maximum of 600 amps. A clamp-on transformer designed into the probe allows measurements to be made without breaking the circuit under test. In use, the current carrying conductor being measured serves as the tranformer's primary, while the 80I-600 serves as the secondary. Because of a high efficiency, quadrature type of winding, wire size and location of the conductor within the transformer jaws do not affect accuracy of the current measurement.

6-12. Specifications

Range: 2 to 600A ac.
Accuracy: ±3%.
Frequency Response: 30 Hz to 1 kHz.
Division Ratio: 1000:1.
Insulation: 5 kV.
Maximum Conductor Size: 2-inch diameter.

6-13. HIGH VOLTAGE PROBE (80K-40)

6-14. Introduction

6-15. The Model 80K-40 extends the voltage measurement capability of the instrument up to 40 kV. Internally, the probe contains a special 1000:1 resistive divider. Metal-film resistor with matched temperature coefficients comprise the divider, and provide the probe with its excellent accuracy and stability characteristics. Also, an unusually high input impedance (1000 MΩ) minimizes circuit loading, and thereby contributes to measurement accuracy.

6-16. Specifications

Voltage Range: 1 kV to 40 kV dc or peak ac, 28 kV rms ac.
Input Resistance:1000 MΩ.
Division Ratio: 1000:1.
Accuracy DC Overall Accuracy: 20 kV to 30 kV ±2% (calibrated at 25 kV).
Upper Limit: Changes linearly from 2% at 30 kV to 4% at 40 kV.
Lower Limit: Changes linearly from 2% at 20 kV to 4% at 1 kV.
Accuracy AC (Overall): ±5% at 60 Hz.

6-17. HIGH FREQUENCY PROBE (81RF)

6-18. Introduction

6-19. The 81RF Probe extends the frequency range of the instrument voltage measurements capability to include 100 kHz to 100 MHz inputs from 0.25 to 30V rms. It

operates in conjunction with the 8020A dc voltage ranges, and provides a dc output that is calibrated to be equivalent to the rms value of a sine wave input.

6-20. Specifications

Frequency Response: ±1 dB from 100 kHz to 100 MHz.
Extended Frequency Response: Useful for relative reading from 20 kHz to 250 MHz.
Response: Responds to peak value of input; calibrated to read rms value of a sine wave.
Voltage Range: 0.25 to 30V rms.
Maximum DC Input: 350V dc.
Input Impedance: 12 MΩ shunted by 15 pF.

6-21. HIGH FREQUENCY PROBE (82RF)

6-22. Introduction

6-23. The Model 82RF High Frequency Probe, Figure 6-1, allows measurements over a frequency range of 100 kHz to 500 MHz from 0.25 to 30V rms. It is designed to be used with voltmeters having an input impedance of 10 megohms ±10%. It may be used with a voltmeter having an input impedance higher than 10 megohms provided the input is externally shunted to make the equivalent input impedance equal to 10 megohms.

6-24. Circuitry within the 82RF consists of a capacitor-coupled rectifier circuit which responds to the peak value of the input waveform. The output is positive polarity dc which is calibrated to be equivalent to the rms value of a sine wave.

6-25. Specifications

Frequency Response: 3 dB from 100 kHz to 500 MHz.
Extended Frequency Response: Useful for relative readings from 20 kHz to 700 MHz.
Response: Responds to peak value of input; calibrated to read rms value of a sine wave.
Voltage Range: 0.25 to 30V rms.
Maximum DC Input: 200V dc.
Input Impedance: 2 MΩ shunted by 4 pF.

6-26. BATTERY ELIMINATOR (A81)

6-27. The A81 Battery Eliminator converts the 8020A from battery to ac-line operation. It is available in a variety of line-power configurations, as shown in Table 6-1. When connected to the 8020A, it effectively removes and replaces the output of the 8020A's battery.

WARNING

DO NOT SUBSTITUTE A CALCULATOR TYPE BATTERY ELIMINATOR FOR THE A81. THESE UNITS DO NOT PROVIDE THE PROTECTION NECESSARY FOR COMMON MODE MEASUREMENTS UP TO 500V DC. ALWAYS USE THE MODEL A81 FOR AC-LINE OPERATION.

Table 6-1. A81 Model vs Input Power

MODEL NO.	INPUT POWER
A81-100	100V ac ±10%, 48 to 62 Hz
A81-115	115V ac ±10%, 48 to 62 Hz
A81-230-1	230V ac ±10%, 48 to 62 Hz (U.S. type plug)
A81-230	230V ac ±10%, 48 to 62 Hz (European type plug)

6-28. CURRENT SHUNT (80J-10)

6-29. Introduction

6-30. The Model 80J-10 Current Shunt extends the current measuring capability of your meter to 10 amps continuous (20 amps for periods not exceeding one minute) DC to 10 kHz at an accuracy of ±0.25% in excess of the voltmeter accuracy.

6-31. Specifications

Shunt: 10 amps at 100 mV.
Accuracy (18°C to 28°C):
DC to 10 kHz: 0.25%.
10 kHz-100 kHz: Rising to 1 dB at 100 kHz typical.
Temperature Coefficient: 0.005%/°C.
Inductance: 18.3 nH in series w/0.01Ω shunt.
Overload: Up to one minute at 20A with a 1/4 duty cycle for recovery after currents between 10A and 20A.
Connects to: 3/4 inch center banana jacks.
Connectors: 5-way binding posts (red and black).

Section 7
Schematic Diagrams

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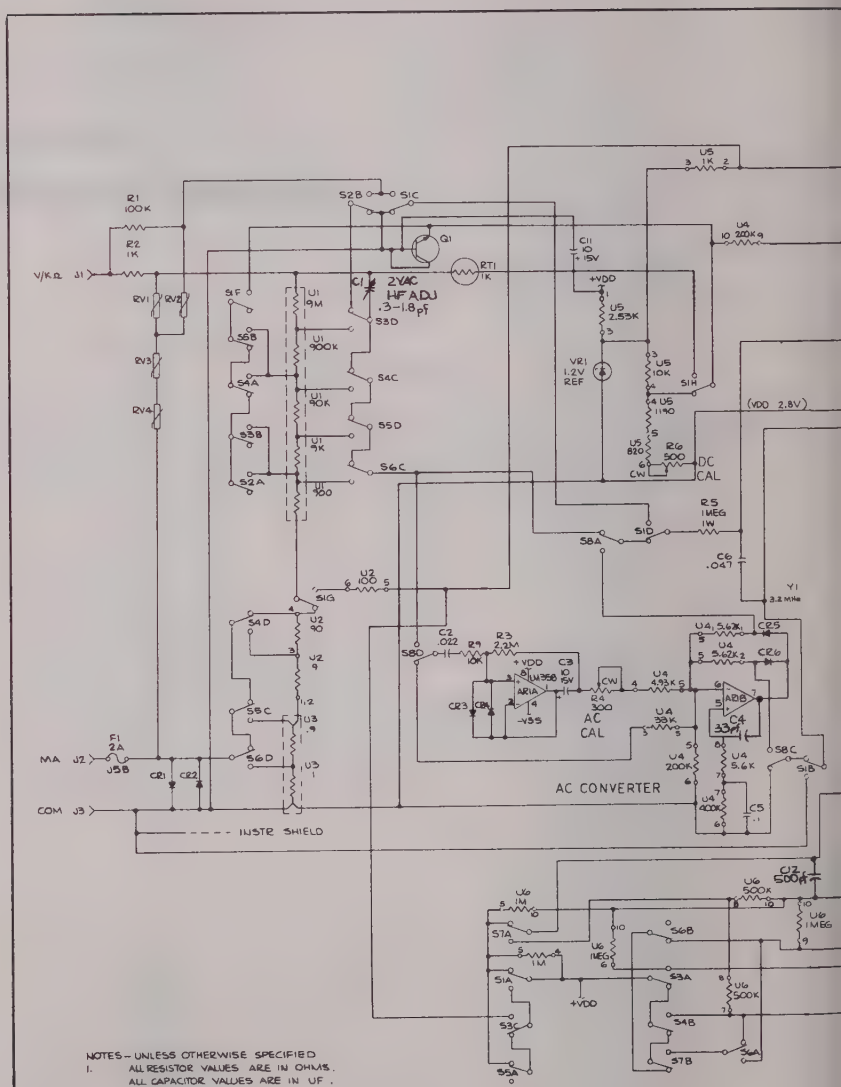
FIGURE	TITLE	PAGE
7-1.	A1 8020A PCB Assembly	7-3



NOTES – UNLESS OTHERWISE SPECIFIED
1. ALL RESISTOR VALUES ARE IN OHMS.
ALL CAPACITOR VALUES ARE IN UF.

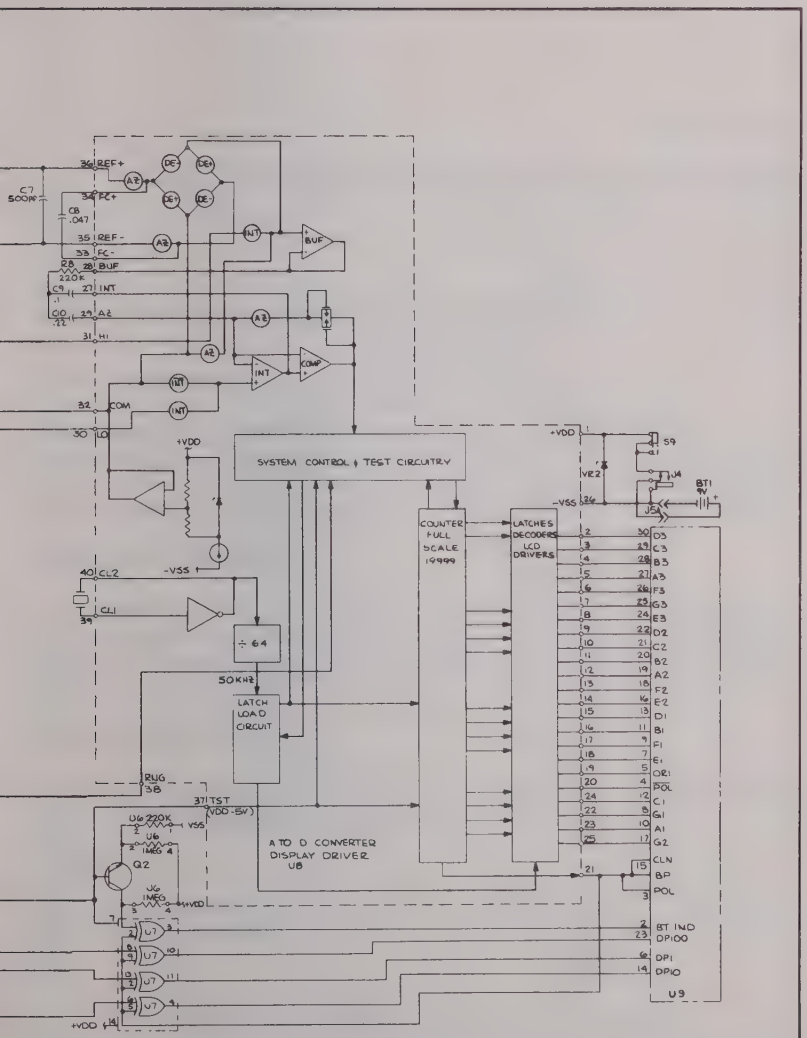


Figure 7-1. A1 8020A PCB Assembly

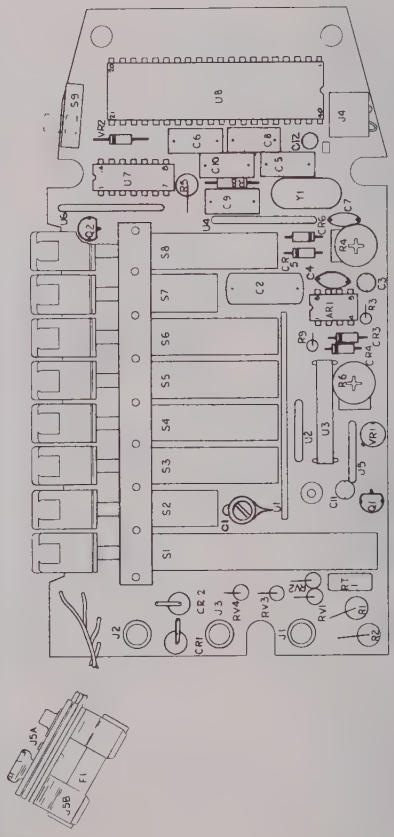


Figure 7-1. A1 8020A PCB Assembly (cont)

Appendix A
Manual Change and Backdating Information

INTRODUCTION

This appendix contains information necessary to backdate the manual to conform with earlier pcb configurations. To identify the configuration of the pcb's used in your instrument, refer to the revision letter (marked in ink) on the component side of each pcb assembly. Table A-1 defines the assembly revision levels documented in this manual.

NEWER INSTRUMENTS

As changes and improvements are made to the instrument, they are identified by incrementing the revision letter marked on the affected pcb assembly. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted at the front of the manual.

OLDER INSTRUMENTS

To backdate this manual to conform with earlier assembly revision levels, perform the changes indicated in Table A-1.

CHANGES

There are no backdating changes at this printing. All pcb assemblies are documented at their original revision level.

Table A-1. Manual Status and Backdating Information

Ref Or Option No.	Assembly Name	Fluke Part No.	* To adapt manual to earlier rev configurations perform changes in desending order (by no.), ending with change under desired rev letter																					
			–	A	B	C	D	E	F	G	H	J	K	L	M	N	P								
A-3	8020A PCB assembly	450783				X																			

* X = The PCB revision levels documented in this manual.
● = These revision letters were never used in the instrument.
-- = No revision letter on the PCB.

LIMITED WARRANTY

The JOHN FLUKE MFG. CO., INC., warrants each voltmeter it manufactures to be free from defects in material and workmanship under normal use and service for the period of 2 years from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90-days), or any product or parts which have been subject to misuse, neglect, accident or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within 2 years of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 2 years of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USE SHALL BE LIMITED TO A PERIOD OF TWENTY-FOUR MONTHS FROM THE DATE OF PURCHASE. THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER EXPRESS WARRANTIES. JOHN FLUKE MFG. CO., INC., SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

NOTE: Some states do not allow limitations on how long an implied warranty lasts, or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

If any failure occurs, the following steps should be taken:

1. Notify the JOHN FLUKE MFG. CO., INC., or nearest Service facility, giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of JOHN FLUKE MFG. CO., INC., instruments should be made via United Parcel Service or "Best Way" prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The JOHN FLUKE MFG. CO., INC. will be happy to answer all application or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX 43210, MOUNTLAKE TERRACE, WASHINGTON 98043, ATTEN: Sales Dept. For European Customers: Fluke (Nederland) B.V., Zevenheuvelenweg 53, Tilburg, The Netherlands.

* For European customers, Air Freight prepaid.

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